# REPORT No. 141

## EXPERIMENTAL RESEARCH ON AIR PROPELLERS, V

By W. F. DURAND and E. P. LESLEY
Leland Stanford Junior University, California

# REPORT No. 141

## EXPERIMENTAL RESEARCH ON AIR PROPELLERS, V.

By W. F. Durand and E. P. Lesley.

### (1) SCOPE OF INVESTIGATION COVERED BY PRESENT REPORT.

National Advisory Committee reports Nos. 14, 30, 64 comprise the results of a series of wind-tunnel tests on model forms of air propellers, extending over a three-year program of experimental work. These reports were made progressively and each without reference to the results given in preceding reports and relating to forms perhaps adjacent in geometrical form and proportion. These reports thus represent a survey, made in three parts, of a somewhat extended area covering a considerable number of model forms and proportions and varying in various characteristics in a systematic and regular manner.

At the conclusion of the work thus carried on in parts, it has seemed desirable to review the entire series of results, to examine through graphical and other appropriate means the nature of the history of the characteristics of operation as related to the systematic variation in characteristics of form, proportions, etc., through the entire series of such variations, to check doubtful points by repetition of test, to remove inconsistencies where found, and generally to develop, for the series of models represented by these tests, a consistent set of results as judged by the relation of those for any one model to those for all models adjacent in geometrical form and proportion.

It is the purpose of the present report to give the results of this general analysis and review of these series of experimental observations.

#### NUMBER AND CHARACTERISTICS OF MODEL FORMS.

The number of model forms included in the analysis which is the subject of the present report is 88. The three reports on which this analysis is primarily based covered a certain number of additional forms, the results for which are not here included. These omitted forms represent unusual or special forms or slight variations from normal types and were intended to indicate the results to be anticipated by such departures from the more normal range of form and proportion. The results derived from these models are generally without valuable or hopeful indications.

There remains the aggregate of 88 models distributed over the range of variations in form and proportion as follows:

| | Variations. |
|---|---|
| Pitch ratio | 6 |
| Area of blade | 2 |
| Form of blade | 2 |
| Form of cross section of blade | 4 |
| Mode of pitch distribution | 4 |

In designating these models, the following notation has been employed:

| | |
|---|---|
| Form of blade contour No. 1 | $F_1$ (see fig. 1). |
| Form of blade contour No. 2 | $F_2$ (see fig. 2). |
| Area of blade No. 1 | $A_1$ (see figs. 1, 2). |
| Area of blade No. 2 | $A_2$ (see figs. 1, 2). |
| Pitch distribution uniform | $P_1$. |
| Pitch distribution according to constant angle of attack 3° | $P_2$. |
| Pitch distribution according to constant angle of attack 6° | $P_3$. |
| Pitch distribution according to constant angle of attack 9° | $P_4$. |
| Driving face of blade plane or without camber | $S_1$ (see figs. 3, 4, 5, 6). |
| Driving face of blade cambered (full) | $S_2$ (see figs. 7, 8, 9, 10). |
| Driving face of blade cambered (half) | $S_3$ (see figs, 11, 12). |
| Driving face of blade convex | $S_4$ (see fig. 13). |

These various models cover the following combinations of characteristics of form and proportion:

| No. | |
|---|---|
| 6 constant $F_1A_1S_1P_1$ with 6 variations in nominal pitch ratio | 0.3, 0.5, 0.7, 0.9, 1.1, 1.3 |
| 6 constant $F_1A_2S_1P_1$ with 6 variations in nominal pitch ratio | 0.3, 0.5, 0.7, 0.9, 1.1, 1.3 |
| 6 constant $F_2A_1S_1P_1$ with 6 variations in nominal pitch ratio | 0.3, 0.5, 0.7, 0.9, 1.1, 1.3 |
| 6 constant $F_2A_2S_1P_1$ with 6 variations in nominal pitch ratio | 0.3, 0.5, 0.7, 0.9, 1.1, 1.3 |
| 3 constant $F_1A_1S_1P_2$ with 3 variations in nominal pitch ratio | 0.5, 0.7, 0.9 |
| 3 constant $F_1A_2S_1P_2$ with 3 variations in nominal pitch ratio | 0.5, 0.7, 0.9 |
| 5 constant $F_2A_1S_1P_2$ with 5 variations in nominal pitch ratio | 0.5, 0.7, 0.9, 1.1, 1.3 |
| 3 constant $F_2A_2S_1P_2$ with 3 variations in nominal pitch ratio | 0.5, 0.7, 0.9 |
| 3 constant $F_1A_1S_2P_1$ with 3 variations in nominal pitch ratio | 0.5, 0.7, 0.9 |
| 3 constant $F_1A_2S_2P_1$ with 3 variations in nominal pitch ratio | 0.5, 0.7, 0.9 |
| 3 constant $F_2A_1S_2P_1$ with 3 variations in nominal pitch ratio | 0.5, 0.7, 0.9 |
| 3 constant $F_2A_2S_2P_1$ with 3 variations in nominal pitch ratio | 0.5, 0.7, 0.9 |
| 3 constant $F_1A_1S_2P_2$ with 3 variations in nominal pitch ratio | 0.5, 0.7, 0.9 |
| 3 constant $F_1A_2S_2P_2$ with 3 variations in nominal pitch ratio | 0.5, 0.7, 0.9 |
| 3 constant $F_2A_1S_2P_2$ with 3 variations in nominal pitch ratio | 0.5, 0.7, 0.9 |
| 3 constant $F_2A_2S_2P_2$ with 3 variations in nominal pitch ratio | 0.5, 0.7, 0.9 |
| 3 constant $F_2A_1S_3P_1$ with 3 variations in nominal pitch ratio | 0.5, 0.7, 0.9 |
| 3 constant $F_2A_2S_3P_1$ with 3 variations in nominal pitch ratio | 0.5, 0.7, 0.9 |
| 5 constant $F_2A_1S_4P_1$ with 5 variations in nominal pitch ratio | 0.5, 0.7, 0.9, 1.1, 1.3 |
| 5 constant $F_2A_1S_1P_3$ with 5 variations in nominal pitch ratio | 0.5, 0.7, 0.9, 1.1, 1.3 |
| 5 constant $F_2A_1S_1P_4$ with 5 variations in nominal pitch ratio | 0.5, 0.7, 0.9, 1.1, 1.3 |

In addition to the above 83 models the report includes results for:

Four models of constant $F_2A_1$ and nominal pitch ratio 0.7, but with maximum thickness of cross-section at 0.17, 0.25, 0.41, and 0.49 of the width from the leading edge. See figures 14, 15, 16, and 17.

One model of constant $F_1A_1S_1$ with blades made adjustable for change of pitch, the pitch being uniform at 0.7 pitch ratio.

The characteristics of these various models in detail will be found in Table I.

TABLE I.—*Model characteristics.*

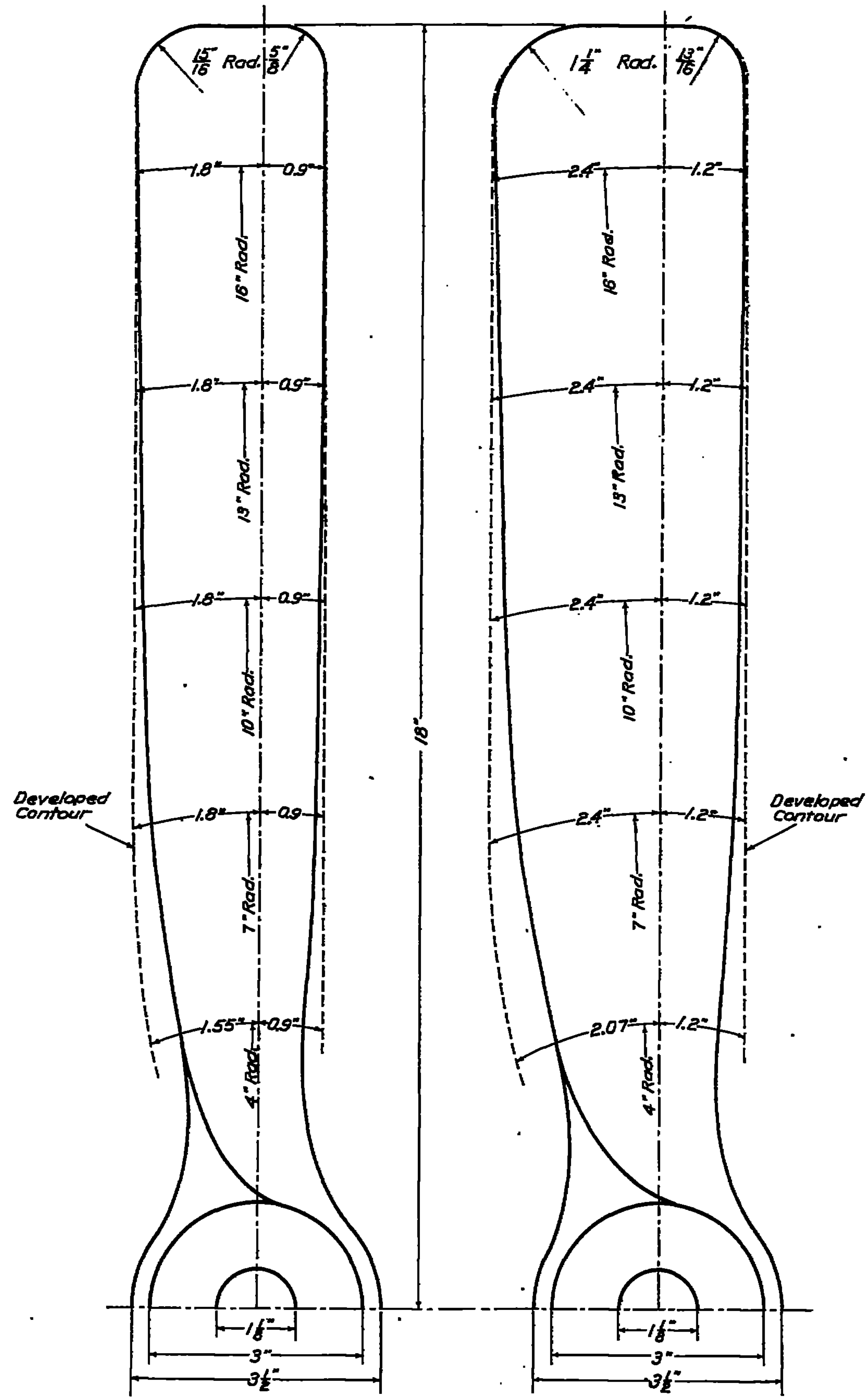
| Number. | Section symbol. | Form symbol. | Area symbol. | Pitch symbol. | Pitch ratio. | Mean blade width. | Number. | Section symbol. | Form symbol. | Area symbol. | Pitch symbol. | Pitch ratio. | Mean blade width. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | $S_1$ | $F_1$ | $A_1$ | $P_1$ | 0.9 | 0.15r | 45 | $S_2$ | $F_1$ | $A_1$ | $P_2$ | 0.5 | 0.15r |
| 2 | $S_1$ | $F_1$ | $A_2$ | $P_1$ | .9 | .20r | 46 | $S_2$ | $F_1$ | $A_2$ | $P_2$ | .5 | .20r |
| 3 | $S_1$ | $F_2$ | $A_1$ | $P_1$ | .9 | .15r | 47 | $S_2$ | $F_2$ | $A_1$ | $P_2$ | .5 | .15r |
| 4 | $S_1$ | $F_2$ | $A_2$ | $P_1$ | .9 | .20r | 48 | $S_2$ | $F_2$ | $A_2$ | $P_2$ | .5 | .20r |
| 5 | $S_1$ | $F_1$ | $A_1$ | $P_1$ | .7 | .15r | 80 | $S_1$ | $F_1$ | $A_1$ | $P_1$ | 1.1 | .15r |
| 6 | $S_1$ | $F_1$ | $A_2$ | $P_1$ | .7 | .20r | 81 | $S_1$ | $F_1$ | $A_2$ | $P_1$ | 1.1 | .20r |
| 7 | $S_1$ | $F_2$ | $A_1$ | $P_1$ | .7 | .15r | 82 | $S_1$ | $F_2$ | $A_1$ | $P_1$ | 1.1 | .15r |
| 8 | $S_1$ | $F_2$ | $A_2$ | $P_1$ | .7 | .20r | 83 | $S_1$ | $F_2$ | $A_2$ | $P_1$ | 1.1 | .20r |
| 9 | $S_1$ | $F_1$ | $A_1$ | $P_1$ | .5 | .15r | 90 | $S_3$ | $F_2$ | $A_1$ | $P_1$ | .5 | .15r |
| 10 | $S_1$ | $F_1$ | $A_2$ | $P_1$ | .5 | .20r | 91 | $S_3$ | $F_2$ | $A_2$ | $P_1$ | .5 | .20r |
| 11 | $S_1$ | $F_2$ | $A_1$ | $P_1$ | .5 | .15r | 92 | $S_3$ | $F_2$ | $A_1$ | $P_1$ | .7 | .15r |
| 12 | $S_1$ | $F_2$ | $A_2$ | $P_1$ | .5 | .20r | 93 | $S_3$ | $F_2$ | $A_2$ | $P_1$ | .7 | .20r |
| 13 | $S_1$ | $F_1$ | $A_1$ | $P_2$ | .9 | .15r | 94 | $S_3$ | $F_2$ | $A_1$ | $P_1$ | .9 | .15r |
| 14 | $S_1$ | $F_1$ | $A_2$ | $P_2$ | .9 | .20r | 95 | $S_3$ | $F_2$ | $A_2$ | $P_1$ | .9 | .20r |
| 15 | $S_1$ | $F_2$ | $A_1$ | $P_2$ | .9 | .15r | 96[1] | $S_1$ | $F_1$ | $A_1$ | $P_1$ | .7 | .15r |
| 16 | $S_1$ | $F_2$ | $A_2$ | $P_2$ | .9 | .20r | 111 | $S_1$ | $F_1$ | $A_1$ | $P_1$ | 1.3 | .15r |
| 17 | $S_1$ | $F_1$ | $A_1$ | $P_2$ | .7 | .15r | 112 | $S_1$ | $F_1$ | $A_2$ | $P_1$ | 1.3 | .20r |
| 18 | $S_1$ | $F_1$ | $A_2$ | $P_2$ | .7 | .20r | 113 | $S_1$ | $F_2$ | $A_1$ | $P_1$ | 1.3 | .15r |
| 19 | $S_1$ | $F_2$ | $A_1$ | $P_2$ | .7 | .15r | 114 | $S_1$ | $F_2$ | $A_2$ | $P_1$ | 1.3 | .20r |
| 20 | $S_1$ | $F_2$ | $A_2$ | $P_2$ | .7 | .20r | 115 | $S_4$ | $F_2$ | $A_1$ | $P_1$ | .5 | .15r |
| 21 | $S_1$ | $F_1$ | $A_1$ | $P_2$ | .5 | .15r | 116 | $S_4$ | $F_2$ | $A_1$ | $P_1$ | .7 | .15r |
| 22 | $S_1$ | $F_1$ | $A_2$ | $P_2$ | .5 | .20r | 117 | $S_4$ | $F_2$ | $A_1$ | $P_1$ | .9 | .15r |
| 23 | $S_1$ | $F_2$ | $A_1$ | $P_2$ | .5 | .15r | 118 | $S_4$ | $F_2$ | $A_1$ | $P_1$ | 1.1 | .15r |
| 24 | $S_1$ | $F_2$ | $A_2$ | $P_2$ | .5 | .20r | 119 | $S_4$ | $F_2$ | $A_1$ | $P_1$ | 1.3 | .15r |
| 25 | $S_2$ | $F_1$ | $A_1$ | $P_1$ | .9 | .15r | 120 | $S_5$ | $F_2$ | $A_1$ | $P_1$ | .7 | .15r |
| 26 | $S_2$ | $F_1$ | $A_2$ | $P_1$ | .9 | .20r | 121 | $S_6$ | $F_2$ | $A_1$ | $P_1$ | .7 | .15r |
| 27 | $S_2$ | $F_2$ | $A_1$ | $P_1$ | .9 | .15r | 122 | $S_7$ | $F_2$ | $A_1$ | $P_1$ | .7 | .15r |
| 28 | $S_2$ | $F_2$ | $A_2$ | $P_1$ | .9 | .20r | 123 | $S_8$ | $F_2$ | $A_1$ | $P_1$ | .7 | .15r |
| 29 | $S_2$ | $F_1$ | $A_1$ | $P_1$ | .7 | .15r | 127 | $S_1$ | $F_2$ | $A_1$ | $P_3$ | .5 | .15r |
| 30 | $S_2$ | $F_1$ | $A_2$ | $P_1$ | .7 | .20r | 128 | $S_1$ | $F_2$ | $A_1$ | $P_4$ | .5 | .15r |
| 31 | $S_2$ | $F_2$ | $A_1$ | $P_1$ | .7 | .15r | 129 | $S_1$ | $F_2$ | $A_1$ | $P_3$ | .7 | .15r |
| 32 | $S_2$ | $F_2$ | $A_2$ | $P_1$ | .7 | .20r | 130 | $S_1$ | $F_2$ | $A_1$ | $P_4$ | .7 | .15r |
| 33 | $S_2$ | $F_1$ | $A_1$ | $P_1$ | .5 | .15r | 131 | $S_1$ | $F_2$ | $A_1$ | $P_3$ | .9 | .15r |
| 34 | $S_2$ | $F_1$ | $A_2$ | $P_1$ | .5 | .20r | 132 | $S_1$ | $F_2$ | $A_1$ | $P_4$ | .9 | .15r |
| 35 | $S_2$ | $F_2$ | $A_1$ | $P_1$ | .5 | .15r | 133 | $S_1$ | $F_2$ | $A_1$ | $P_2$ | 1.1 | 15r |
| 36 | $S_2$ | $F_2$ | $A_2$ | $P_1$ | .5 | .20r | 134 | $S_1$ | $F_2$ | $A_1$ | $P_3$ | 1.1 | .15r |
| 37 | $S_2$ | $F_1$ | $A_1$ | $P_2$ | .9 | .15r | 135 | $S_1$ | $F_2$ | $A_1$ | $P_4$ | 1.1 | .15r |
| 38 | $S_2$ | $F_1$ | $A_2$ | $P_2$ | .9 | .20r | 136 | $S_1$ | $F_2$ | $A_1$ | $P_2$ | 1.3 | .15r |
| 39 | $S_2$ | $F_2$ | $A_1$ | $P_2$ | .9 | .15r | 137 | $S_1$ | $F_2$ | $A_1$ | $P_3$ | 1.3 | .15r |
| 40 | $S_2$ | $F_2$ | $A_2$ | $P_2$ | .9 | .20r | 138 | $S_1$ | $F_2$ | $A_1$ | $P_4$ | 1.3 | .15r |
| 41 | $S_2$ | $F_1$ | $A_1$ | $P_2$ | .7 | .15r | 139 | $S_1$ | $F_2$ | $A_1$ | $P_1$ | .3 | .15r |
| 42 | $S_2$ | $F_1$ | $A_2$ | $P_2$ | .7 | .20r | 144 | $S_1$ | $F_2$ | $A_2$ | $P_1$ | .3 | .20r |
| 43 | $S_2$ | $F_2$ | $A_1$ | $P_2$ | .7 | .15r | 145 | $S_1$ | $F_1$ | $A_1$ | $P_1$ | .3 | .15r |
| 44 | $S_2$ | $F_2$ | $A_2$ | $P_2$ | .7 | .20r | 146 | $S_1$ | $F_1$ | $A_2$ | $P_1$ | .3 | .20r |

[1] Adjustable pitch.

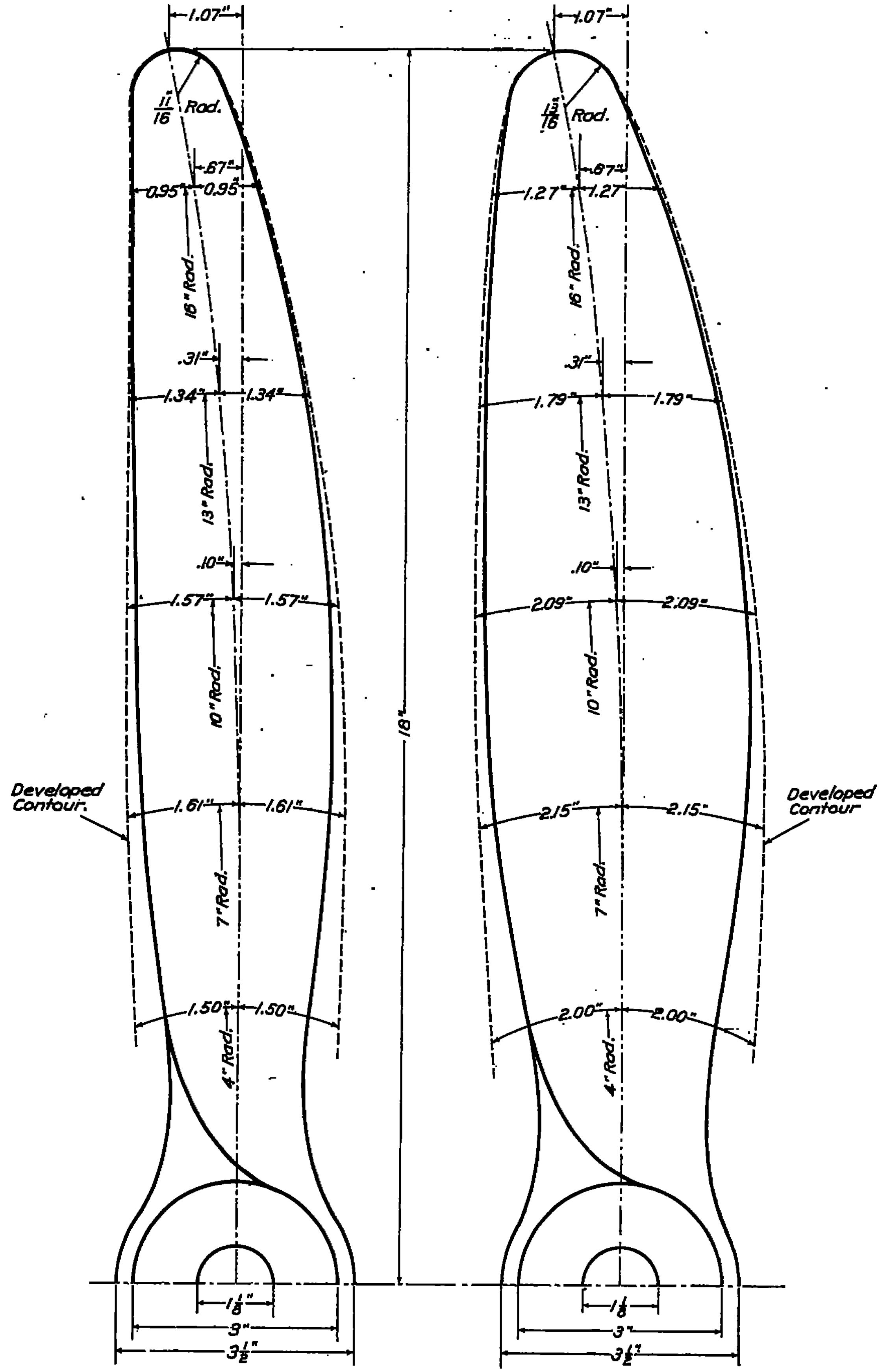
TABLE II.—*Dimensions of sections (see Fig. 18).*

| Fig. No. | Section form and area. | Radius of section. | AB. | AE. | AC and BD. | EG. | EH. | EM. | RS. | O. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Symbols.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Degrees.* |
| 3 | $S_1 F_1 A_1$ | 4 | 2.45 | 0.90 | 0.05 | 0.70 | 1.19 | | 0.15 | 78 |
| | | 7 | 2.70 | .90 | .05 | .60 | 1.01 | | | 69 |
| | | 10 | 2.70 | .90 | .05 | .50 | .84 | | | 60 |
| | | 13 | 2.70 | .90 | .05 | .40 | .66 | | | 51 |
| | | 16 | 2.70 | .90 | .05 | .30 | .49 | | | 42 |
| 4 | $S_1 F_1 A_2$ | 4 | 3.27 | 1.20 | .05 | .70 | 1.19 | | .20 | 78 |
| | | 7 | 3.60 | 1.20 | .05 | .60 | 1.01 | | | 69 |
| | | 10 | 3.60 | 1.20 | .05 | .50 | .84 | | | 60 |
| | | 13 | 3.60 | 1.20 | .05 | .40 | .66 | | | 51 |
| | | 16 | 3.60 | 1.20 | .05 | .30 | .49 | | | 42 |
| 5 | $S_1 F_2 A_1$ | 4 | 3.00 | 1.00 | .05 | .70 | 1.19 | | .18 | 78 |
| | | 7 | 3.22 | 1.07 | .05 | .60 | 1.01 | | | 69 |
| | | 10 | 3.14 | 1.05 | .05 | .50 | .84 | | | 60 |
| | | 13 | 2.68 | .89 | .05 | .40 | .66 | | | 51 |
| | | 16 | 1.90 | .63 | .05 | .30 | .49 | | | 42 |
| 6 | $S_1 F_2 A_2$ | 4 | 4.00 | 1.33 | .05 | .70 | 1.19 | | .25 | 78 |
| | | 7 | 4.30 | 1.43 | .05 | .60 | 1.01 | | | 69 |
| | | 10 | 4.18 | 1.39 | .05 | .50 | .84 | | | 60 |
| | | 13 | 3.58 | 1.19 | .05 | .40 | .66 | | | 51 |
| | | 16 | 2.54 | .85 | .05 | .30 | .49 | | | 42 |
| 7 | $S_2 F_1 A_1$ | 4 | 2.45 | .90 | .05 | .70 | 1.19 | | | 78 |
| | | 7 | 2.70 | .90 | .05 | .60 | 1.01 | 0.17 | | 69 |
| | | 10 | 2.70 | .90 | .05 | .50 | .84 | .17 | | 60 |
| | | 13 | 2.70 | .90 | .05 | .40 | .66 | .13 | | 51 |
| | | 16 | 2.70 | .90 | .05 | .30 | .49 | .10 | | 42 |
| 8 | $S_2 F_1 A_2$ | 4 | 3.27 | 1.20 | .05 | .70 | 1.19 | | | 78 |
| | | 7 | 3.60 | 1.20 | .05 | .60 | 1.01 | .17 | | 69 |
| | | 10 | 3.60 | 1.20 | .05 | .50 | .84 | .17 | | 60 |
| | | 13 | 3.60 | 1.20 | .05 | .40 | .66 | .13 | | 51 |
| | | 16 | 3.60 | 1.20 | .05 | .30 | .49 | .10 | | 42 |
| 9 | $S_2 F_2 A_1$ | 4 | 3.00 | 1.00 | .05 | .70 | 1.19 | | | 78 |
| | | 7 | 3.22 | 1.07 | .05 | .60 | 1.01 | .17 | | 69 |
| | | 10 | 3.14 | 1.05 | .05 | .50 | .84 | .17 | | 60 |
| | | 13 | 2.68 | .89 | .05 | .40 | .66 | .13 | | 51 |
| | | 16 | 1.90 | .63 | .05 | .30 | .49 | .10 | | 42 |
| 10 | $S_2 F_2 A_2$ | 4 | 4.00 | 1.33 | .05 | .70 | 1.19 | | | 78 |
| | | 7 | 4.30 | 1.43 | .05 | .60 | 1.01 | .17 | | 69 |
| | | 10 | 4.18 | 1.39 | .05 | .50 | .84 | .17 | | 60 |
| | | 13 | 3.58 | 1.19 | .05 | .40 | .66 | .13 | | 51 |
| | | 16 | 2.54 | .85 | .05 | .30 | .49 | .10 | | 42 |
| 11 | $S_3 F_2 A_1$ | 4 | 3.00 | 1.00 | .05 | .70 | 1.19 | | | 78 |
| | | 7 | 3.22 | 1.07 | .05 | .60 | 1.01 | .08 | | 69 |
| | | 10 | 3.14 | 1.05 | .05 | .50 | .84 | .08 | | 60 |
| | | 13 | 2.68 | .89 | .05 | .40 | .66 | .07 | | 51 |
| | | 16 | 1.90 | .63 | .05 | .30 | .49 | .05 | | 42 |
| 12 | $S_3 F_2 A_2$ | 4 | 4.00 | 1.33 | .05 | .70 | 1.19 | | | 78 |
| | | 7 | 4.30 | 1.43 | .05 | .60 | 1.01 | .08 | | 69 |
| | | 10 | 4.18 | 1.39 | .05 | .50 | .84 | .08 | | 60 |
| | | 13 | 3.58 | 1.19 | .05 | .40 | .66 | .07 | | 51 |
| | | 16 | 2.54 | .85 | .05 | .30 | .49 | .05 | | 42 |
| 13 | $S_4 F_2 A_1$ | 4 | 3.00 | 1.00 | .05 | .70 | 1.19 | | .18 | 78 |
| | | 7 | 3.22 | 1.07 | .05 | .60 | 1.01 | | .08 | 69 |
| | | 10 | 3.14 | 1.05 | .05 | .50 | .84 | | .08 | 60 |
| | | 13 | 2.68 | .89 | .05 | .40 | .66 | | .07 | 51 |
| | | 16 | 1.90 | .63 | .05 | .30 | .49 | | .05 | 42 |
| 14 | $S_5 F_2 A_1$ | 4 | 3.00 | .51 | .05 | .70 | 1.19 | | .18 | 78 |
| | | 7 | 3.22 | .55 | .05 | .60 | 1.01 | | | 69 |
| | | 10 | 3.14 | .53 | .05 | .50 | .84 | | | 60 |
| | | 13 | 2.68 | .46 | .05 | .40 | .66 | | | 51 |
| | | 16 | 1.90 | .32 | .05 | .30 | .49 | | | 42 |
| 15 | $S_6 F_2 A_1$ | 4 | 3.00 | .75 | .05 | .70 | 1.19 | | .18 | 78 |
| | | 7 | 3.22 | .81 | .05 | .60 | 1.01 | | | 69 |
| | | 10 | 3.14 | .78 | .05 | .50 | .84 | | | 60 |
| | | 13 | 2.68 | .67 | .05 | .40 | .66 | | | 51 |
| | | 16 | 1.90 | .47 | .05 | .30 | .49 | | | 42 |
| 16 | $S_7 F_2 A_1$ | 4 | 3.00 | 1.23 | .05 | .70 | 1.19 | | .18 | 78 |
| | | 7 | 3.22 | 1.32 | .05 | .60 | 1.01 | | | 69 |
| | | 10 | 3.14 | 1.29 | .05 | .50 | .84 | | | 60 |
| | | 13 | 2.68 | 1.10 | .05 | .40 | .66 | | | 51 |
| | | 16 | 1.90 | .78 | .05 | .30 | .49 | | | 42 |
| 17 | $S_8 F_2 A_1$ | 4 | 3.00 | 1.47 | .05 | .70 | 1.19 | | .18 | 78 |
| | | 7 | 3.22 | 1.58 | .05 | .60 | 1.01 | | | 69 |
| | | 10 | 3.14 | 1.54 | .05 | .50 | .84 | | | 60 |
| | | 13 | 2.68 | 1.31 | .05 | .40 | .66 | | | 51 |
| | | 16 | 1.90 | .93 | .05 | .30 | .49 | | | 42 |

The dimensions of the sections shown in figures 3 to 17 are given in Table II, reference being made to figure 18.




$F_1\ A_1$ Fig. 1 $F_1\ A_2$




$F_2 A_1$ Fig. 2 $F_2 A_2$

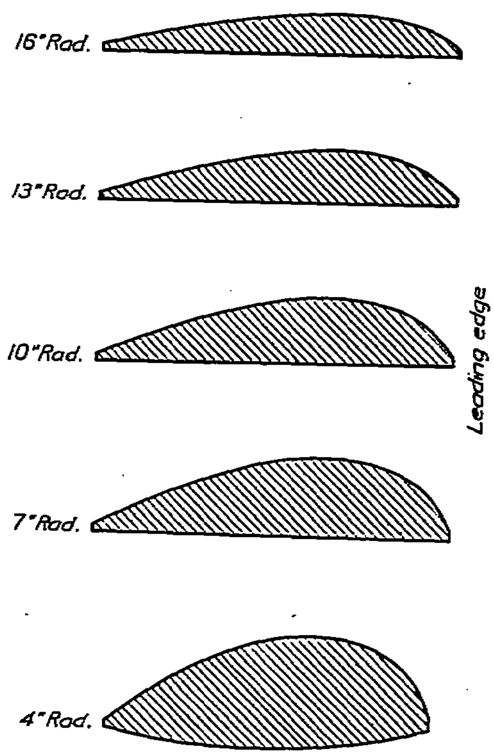



Fig. 3 $S_1 F_1 A_1$

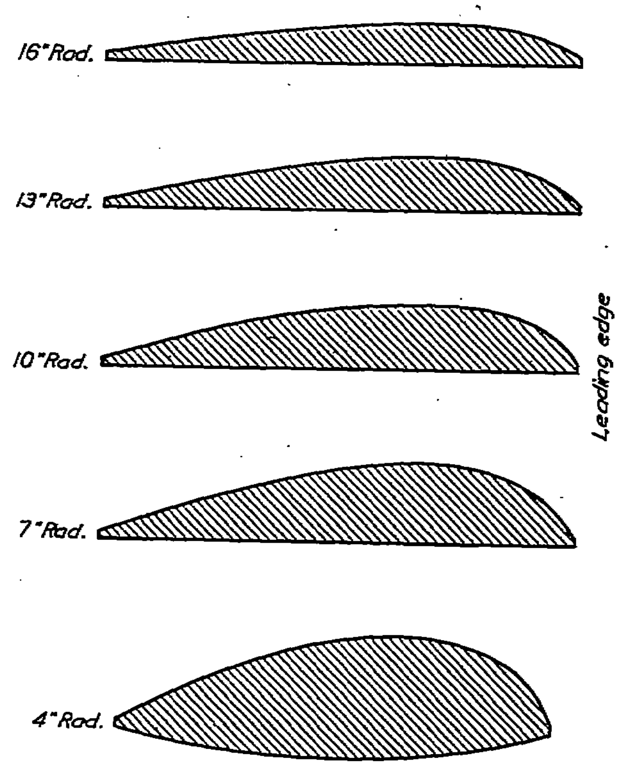



Fig. 4 $S_1 F_1 A_2$

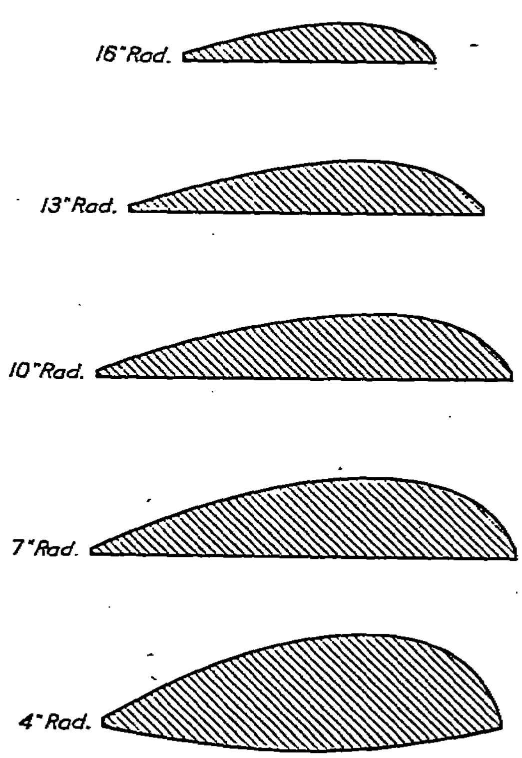



Fig. 5 $S_1 F_2 A_1$

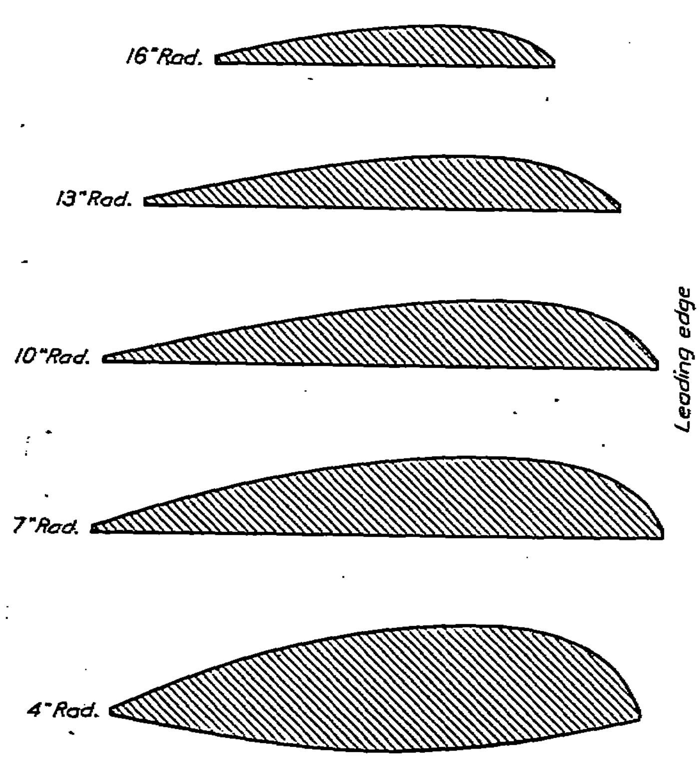



Fig. 6 $S_1 F_2 A_2$

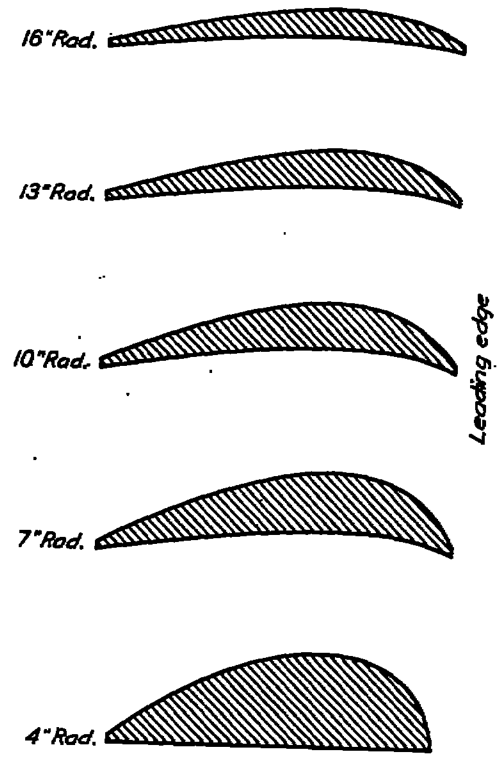



Fig. 7 $S_2 F_1 A_1$

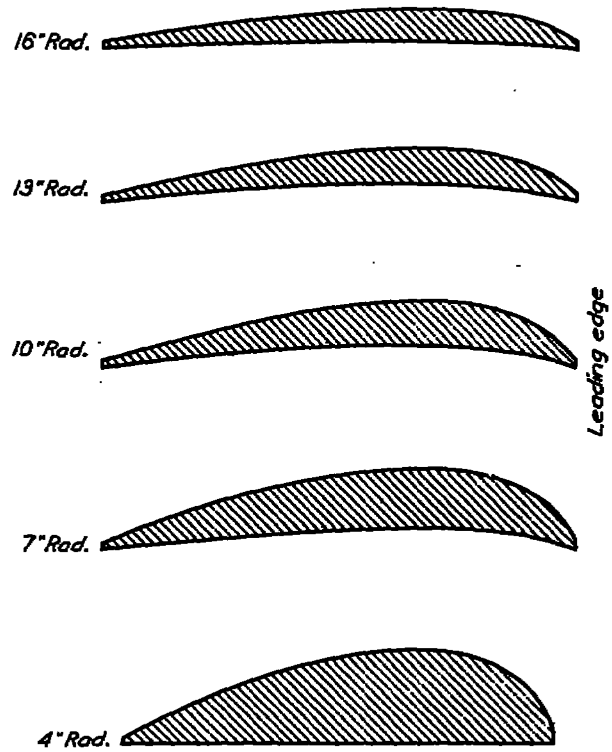



Fig. 8 $S_2 F_1 A_2$

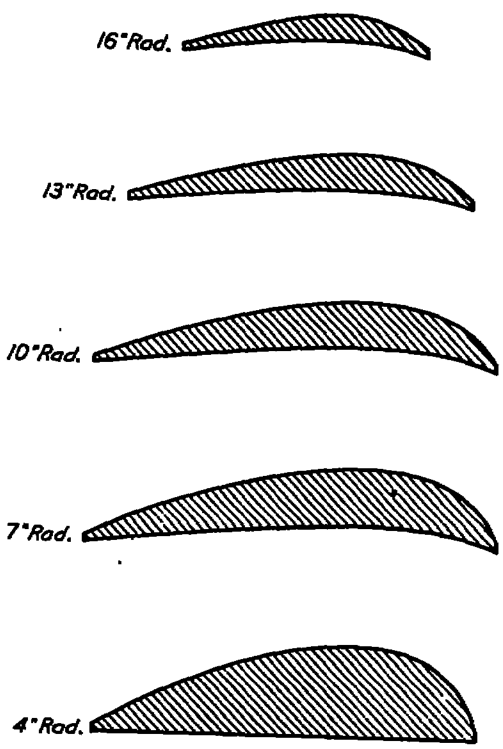



Fig. 9 $S_2 F_2 A_1$

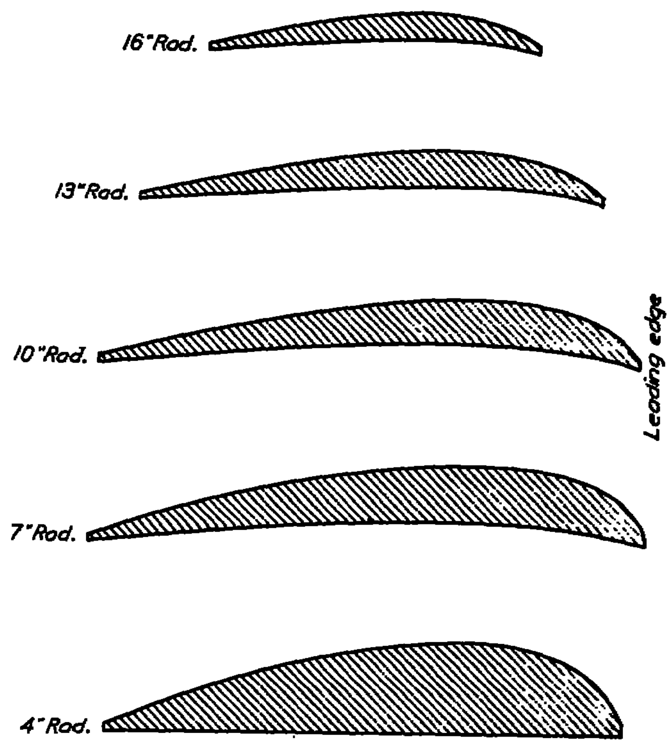



Fig. 10 $S_2 F_2 A_2$

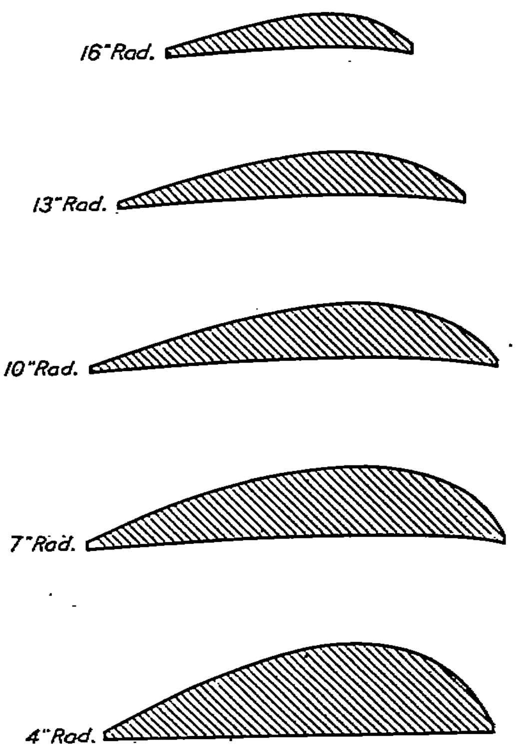



Fig. 11 $S_3 F_2 A_1$

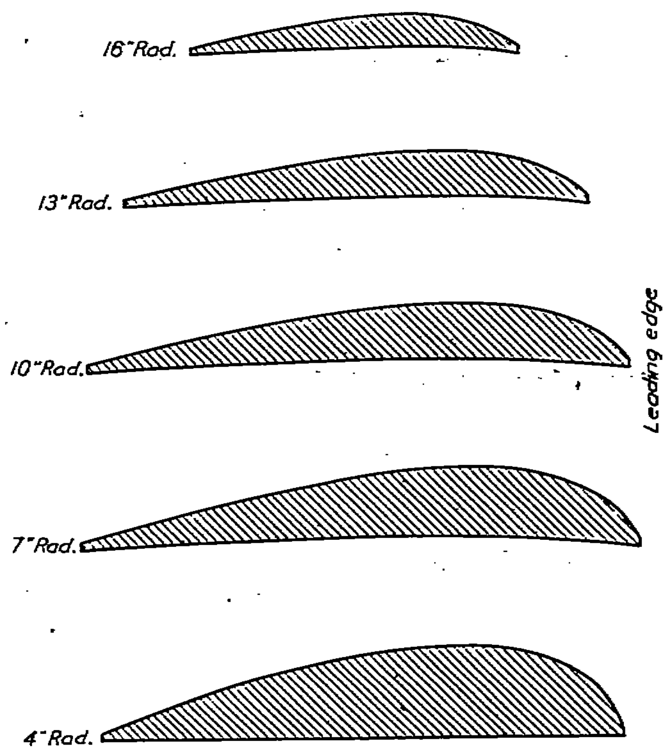



Fig. 12 $S_3 F_2 A_2$

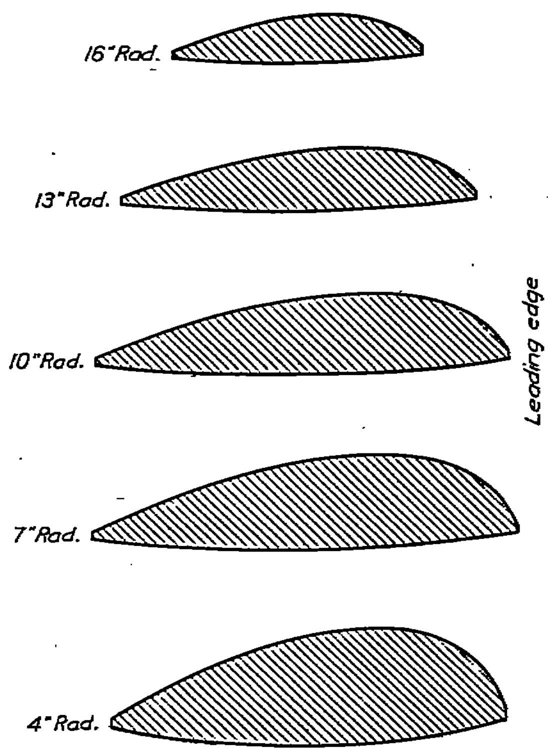



Fig. 13 $S_4 F_2 A_1$

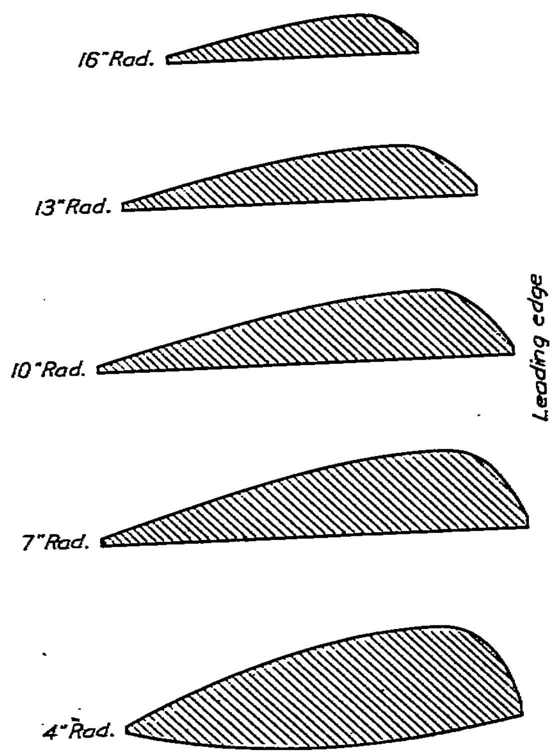



Fig. 14 $S_5 F_2 A_1$

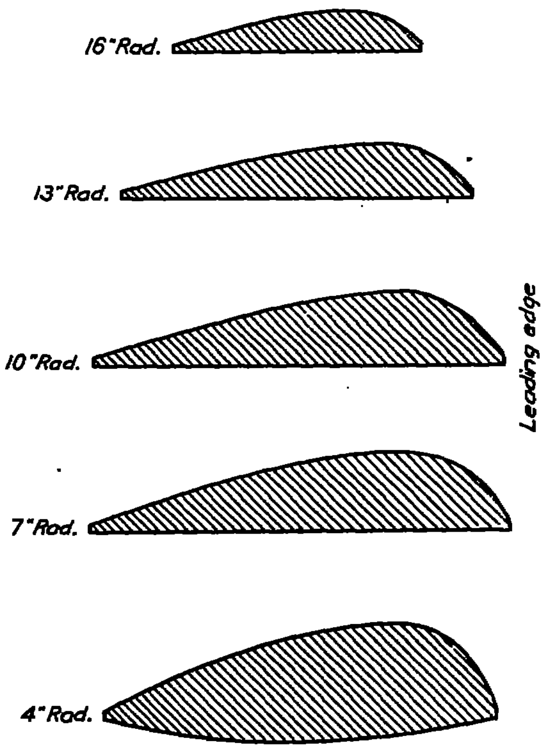



Fig 15 $S_8 F_2 A_1$

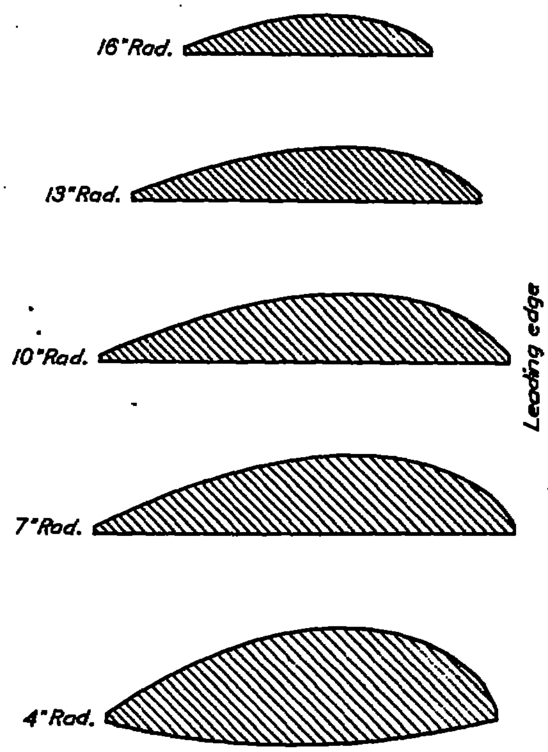



Fig.16 $S_7 F_2 A_1$

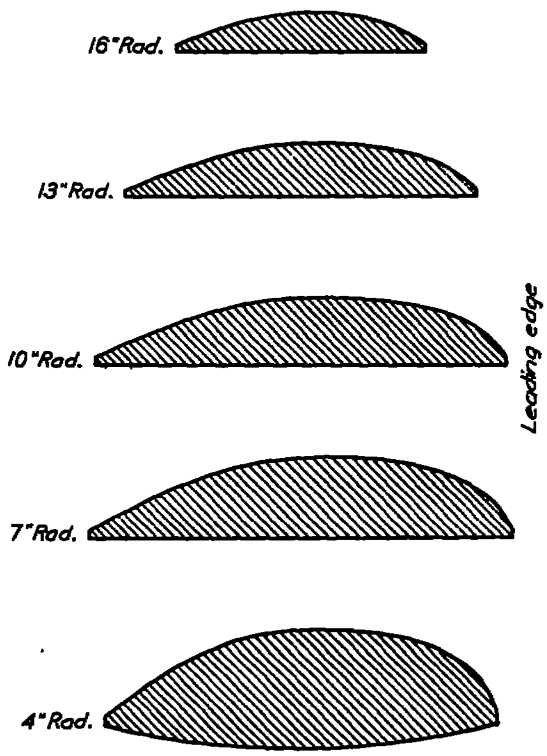



Fig.17 $S_8 F_2 A_1$

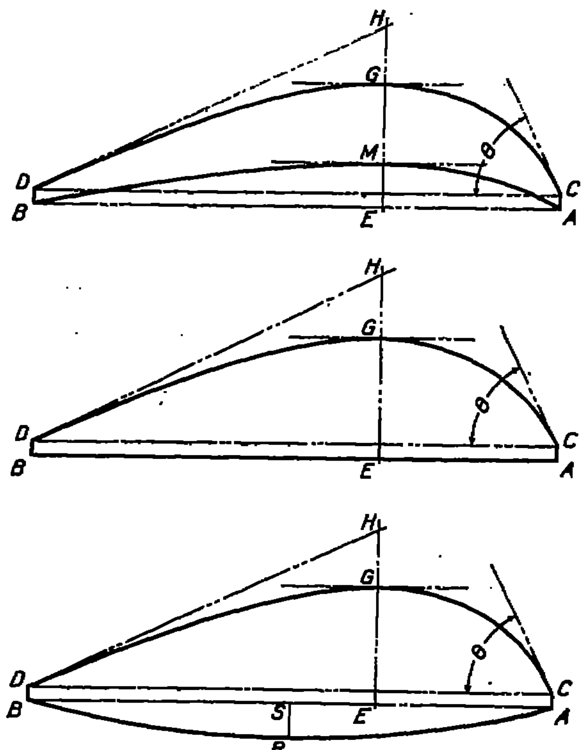



Fig.18

These models furthermore permit of grouping in such manner as to give results for the following series of graded variations:

6 variations of pitch ratio with 4 combinations of ........ $F\ A\ S\ P$.
5 variations of pitch ratio with 4 other combinations of ........ $F\ A\ S\ P$.
3 variations of pitch ratio with 18 other combinations of ........ $F\ A\ S\ P$.
2 variations of contour with 30 combinations of ........ $A\ S\ P$ with pitch ratio.
2 variations of blade area with 33 combinations of ........ $F\ S\ P$ with pitch ratio.
2 variations of blade section with 24 combinations of ........ $F\ A\ P$ with pitch ratio.
3 variations of blade section with 6 other combinations of ........ $F\ A\ P$ with pitch ratio.
4 variations of blade section with 5 other combinations of ........ $F\ A\ P$ with pitch ratio.
2 variations of pitch distribution with 26 combinations of ........ $F\ A\ S$ with pitch ratio.
4 variations of pitch distribution with 5 other combinations of ........ $F\ A\ S$ with pitch ratio.

### METHOD OF TEST.

The general method of test has already been described in preceding reports (Nos. 14, 30) and need not be more especially referred to at this point.

### (2) REDUCTION OF EXPERIMENTAL RESULTS.

For the reduction of experimental model results to forms suited to use in practical problems, the following notation is employed.

$D$ = diameter.
$N$ = revolutions.
$V$ = velocity.
$\Delta$ = density of air.
$H$ = altitude.
$T$ = thrust.
$Q$ = torque.
$P$ = effective power (power delivered by engine to propeller).
$P_1$ = useful power (utilized by propeller for propulsion of plane).
$\eta$ = efficiency = $P_1 \div P$.
$B$, $C$ = coefficients variously specified by subscript, and serving to relate $T$, $Q$, $P$, or $P_1$ to some function of $V$, $D$, $N$.
$x = V/ND$.

#### COEFFICIENTS OF THRUST, TORQUE, AND POWER.

The law of comparison which is accepted for the discussion of experimental results on model air propellers and for the purpose of making use of such results in connection with practical problems relating to full size propellers, may be stated thus:

For propellers of similar geometrical form and at equal values of the function $V/ND$ the following relations hold

$$T \sim V^2D^2 \tag{1}$$

$$Q \sim V^2D^3 \tag{2}$$

These relations may be expressed in the form of equations by the introduction of coefficients $B_1$, $B_2$. In order furthermore to make these cofficients non-dimensional while at the same time measuring $T$ and $Q$ themselves in gravitational units, we may introduce the factor $g$, thus giving equations as follows:

$$gT = B_1 \Delta V^2 D^2 \tag{3}$$

$$gQ = B_2 \Delta V^2 D^3 \tag{4}$$

This gives for the coefficients $B_1$ and $B_2$ the values:

$$B_1 = \frac{gT}{\Delta V^2 D^2} \tag{5}$$

$$B_2 = \frac{gQ}{\Delta V^2 D^3} \tag{6}$$

We may now restate the assumed law of comparison as follows:

For propellers of similar geometrical form and at equal values of the function $V/ND$, values of $B_1$ in (5) will be the same independent of absolute size; and likewise for values of $B_2$ in (6).

If then we multiply equation (5) by the equation $x^n = (V/ND)^n$ it is evident that we shall have, on the left, a new coefficient, likewise independent of absolute size, and expressed in form as determined by the right hand member of the resulting equation.

This will be clear by holding in mind two propellers of similar geometrical form and operating at the same value of $V/ND$. For these particular conditions, the values of the coefficient $B_1$, for each propeller, will be the same. If then this single value of $B_1$ be multiplied by the value of $V/ND$ we shall have a new single value, likewise applicable to these two propellers operating at this value of $V/ND$. We may similarly multiply or divide by any power of $V/ND$ or by $(V/ND)^n$ where $n$ may have any value positive or negative.

We may thus derive an indefinite series of coefficients, all relating to thrust, and in each case fulfilling the condition of equal values of coefficient for equal values of $V/ND$ for two propellers of similar geometrical form; and if for some two propellers, then for any two and hence for any number, so long as they belong to the same family as regards geometrical type or form.

Thus by way of example, by suitably selecting the index of $V/ND$, we derive coefficients for $T$ related as follows to the variables $V$, $D$, $N$, $\Delta$:

$$\frac{gT}{\Delta V^2 D^2},\ \frac{gT}{\Delta N^2 D^4},\ \frac{gT}{\Delta V^4 N^{-2}},\ \frac{gT}{\Delta V N D^3} \tag{7}$$

It will be noted that of these four examples, the first involves $V$ and $D$, the second $N$ and $D$, the third $V$ and $N$ and the fourth $V$, $N$, $D$.

We may derive similarly coefficients for Q as follows:

$$\frac{gQ}{\Delta V^2 D^3},\ \frac{gQ}{\Delta N^2 D^5},\ \frac{gQ}{\Delta V^5 N^{-3}},\ \frac{gQ}{\Delta V N D^4} \tag{8}$$

Turning now to power we have immediately from (3) and (4)

$$gP_1 = gTV = B_1 \Delta V^3 D^2 \tag{9}$$

$$gP = 2\pi g Q N = 2\pi_1 B_2 \Delta N V^2 D^3 \tag{10}$$

Hence

$$\frac{P_1}{P} = \eta = \frac{B_1}{2\pi B_2} \cdot \frac{V}{ND} \tag{11}$$

But for any two propellers geometrically similar in form and at the same value of $V/ND$, the two values of $B_1$ are the same, and likewise for $B_2$, while by specification $V/ND$ is the same. Hence from (11), the efficiency will be the same.

This means specifically that for any pair of propellers geometrically similar in form and operating at equal values of $V/ND$, the efficiencies will be the same; or more broadly, that throughout all the members of a given family of propellers of the same geometrical form, a given value of $V/ND$ will fix the efficiency; or otherwise, that for a given family of the same geometrical form, efficiency is a function of $V/ND$ only.

From (9) we have the coefficient,

$$B_1 = \frac{gP_1}{\Delta V^3 D^2} \tag{12}$$

In the same manner as for $T$ and $Q$ we may now derive a series of coefficients from that defined as in (12), by multiplication or division by powers of $V/ND$. We may thus derive in particular three coefficents as follows:

$$\frac{gP_1}{\Delta N^3 D^5},\ \frac{gP_1}{\Delta V^3 D^2},\ \frac{gP_1}{\Delta V^5 N^{-2}} \tag{13}$$

There will obviously be three similar coefficients for the effective power $P$ which may be derived from (10) in the same manner in which those expressed in (13) are derived from (9). It is clear, however, that if for two similar propellers at the same value of $V/ND$ there is a numerical coefficient relating $P_1$ to some function of $V$, $N$, $D$, and which numerical coefficient is the same for both propellers, then since the efficiency is also the same, there will be another numerical coefficient relating $P$ to the same function of $V$, $N$, $D$, and which numerical coefficient will likewise be the same for both propellers.

We may therefore use coefficients having the forms given in (13) and derived either from $P_1$ or from $P$.

For present purposes we shall use the effective power $P$ as the primary power quantity and we shall denote the three coefficients derived from effective power and having forms as above, respectively by $C_1$, $C_2$, $C_3$.

We shall have then for these coefficients:

$$C_1 = \frac{gP}{\Delta N^3 D^5} \tag{14a}$$

$$C_2 = \frac{gP}{\Delta V^3 D^2} \tag{14b}$$

$$C_3 = \frac{gP}{\Delta V^5 N^{-2}} \tag{14c}$$

The following relations will be noted:

$$\begin{aligned} C_1 &= (V/ND)^3 C_2 \\ C_2 &= (V/ND)^2 C_3 \end{aligned} \tag{15}$$

With any consistent set of units, we shall then have a set of coefficients $C_1$, $C_2$, $C_3$ independent of the system of units as such, and hence the same for either metric or English measures.

It results furthermore that in these basic formulæ, power is measured in kilogram-meters per second or foot-pounds per second and not horsepower. Likewise speed is measured in meters per second or feet per second and not kilometers per hour or miles per hour.

Collecting these various equations we have as follows:

$$gP = C_1 \Delta N^3 D^5 \tag{16}$$

$$gP = C_2 \Delta V^3 D^2 \tag{17}$$

$$gP = C_3 \Delta V^5 N^{-2} \tag{18}$$

$$X = V/ND \tag{19}$$

$$P_1 = \eta P \tag{20}$$

$\eta$ = function of $V/ND$ as in tables or diagrams

$$T = P_1 \div V \tag{21}$$

$$Q = P \div 2\pi N \tag{22}$$

In the use of these equations it must be remembered that the units are:

Metric: meter, kilogram, second.

English: foot, pound, second.

Hence $D$ is measured in meters or feet.

$N$ is measured in revolutions per second.

V is measured in meters per second, or feet per second.

$\Delta$ is measured in kilos. per cubic meter, or pounds per cubic foot.

$P$ is measured in kilogram meters per second, or foot-pounds per second.

$T$ is measured in kilograms, or pounds.

$Q$ is measured in kilogram-meters, or pound-feet.

With these units, as previously noted, the values of $C_1$, $C_2$, $C_3$ will be nondimensional, and hence the same with either metric or English units.

If any of these various quantities are expressed in terms of other units such as horsepower (metric or English), kilometers per hour, or miles per hour, they must be reduced to values in terms of the above units before direct use is made of the formulæ with the numerical values of $C_1$, $C_2$, $C_3$ as in Table VIII or figures 19 to 52.

The actual test results are then put in the form of the following series of items.

#### TABULAR.

Values of coefficient $C_1$ on $V/ND$ as argument.
Values of coefficient $C_2$ on $V/ND$ as argument.
Values of coefficient $C_3$ on $V/ND$ as argument.
Values of efficiency $\eta$ on $V/ND$ as argument.
See Table VIII.

#### GRAPHIC.

Values of coefficient $C_1$ plotted on $V/ND$ as independent variable.
Values of efficiency $\eta$ spotted on curves of $C_1$ as above.
(See figs. 19 to 52.)

#### APPLICATION OF EQUATIONS (16), (17), (18) TO PRACTICAL PROBLEMS.

Of the nine quantities $P_1$, $P$, $V$, $N$, $D$, $\Delta$, $H$, $\eta$, $x$, with the three coefficients $C_1$, $C_2$, $C_3$, some combination of which will enter into such problems, we may note first that:

$P_1$, is dependent on $\eta$ and $P$, being related as in (20).

$\eta$ is dependent on $x$, being determined and expressed both in tabular form and graphically as a function of $x$ alone.
(See also (11).)

The three coefficients $C_1$, $C_2$, $C_3$, are dependent on $x$ and are so determined and given in tabular and graphic form.
(See Table VIII and figs. 19 to 52.)

$H$ is dependent on $\Delta$ being connected by the relation between altitude and the density of the air.

There remain then six variables, $P$, $V$, $N$, $D$, $\Delta$, $x$, any four of which (with one exception to be noted later) may be taken as the necessary and sufficient specification of a problem.

The number of type problems which may thus arise involving combinations of these six quantities would be then the number of combinations of six things taken four at a time. This number is 15 and the combinations are as shown in column 1 of Table III.

TABLE III.

| No. | (1) Knowns. | (2) Unknowns. | (3) C. | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| 1 | Δ V D N | P x | √ | √ | √ | * |
| 2 | x V D N | P Δ | ....... | ....... | ....... | ....... |
| 3 | x Δ D N | P V | √ | √ | √ | * |
| 4 | x Δ V N | P D | √ | √ | √ | * |
| 5 | x Δ V D | P N | √ | √ | √ | * |
| 6 | P V D N | x Δ | √ | √ | √ | * |
| 7 | P Δ D N | x V | √ | ....... | ....... | ....... |
| 8 | P Δ V N | x D | ....... | ....... | √ | ....... |
| 9 | P Δ V D | x N | ....... | √ | ....... | ....... |
| 10 | P x D N | Δ V | √ | √ | √ | * |
| 11 | P x V N | Δ D | √ | √ | √ | * |
| 12 | P x V D | Δ N | √ | √ | √ | * |
| 13 | P x Δ N | V D | √ | ....... | √ | ....... |
| 14 | P x Δ D | V N | √ | √ | ....... | ....... |
| 15 | P x Δ V | D N | ....... | √ | √ | ....... |

Of these 15 combinations, all represent possible physical problems except the second, involving $x$, $V$, $D$, $N$. Since $x = V/ND$ it is clear that we can not arbitrarily take values of more than three of these particular four quantities. This is the exception referred to above.

In column (2) are given the unkowns for the several cases as noted. If the value of $x$ is among the knowns, the value of the efficiency will follow immediately from Table VIII or figures 19 to 52. Otherwise, if $x$ is among the unknowns, its value will result immediately from equation (19) as soon as $V$, $D$, and $N$ are known. Once $\eta$ is known, the useful power $P$, together with the thrust $T$ and torque $Q$, may be readily found from equations (20), (21), (22), if desired.

In column (3) a check mark indicates the cases which may be solved by equation (14a) or through the coefficient $C_1$ as defined by this equation. Similarly, in columns (4) and (5), check marks denote the cases which may be solved respectively by equations (14b) and (14c) or through the coefficients $C_2$, $C_3$ as defined by these equations.

The cases checked in column (3) are in effect those in which the four knowns of column (1) are found in equation (1) and similarly for those of columns (4) and (5).

The stars in column (6) denote the cases which are checked in all three columns—that is, the cases which may be solved by any or all of the three equations.

In addition to these eight cases, it will be noted that cases (13), (14), and (15) may be solved by either or both of two equations, while numbers (7), (8), (9) permit each of solution through one equation only as indicated.

By the use of these equations, as choice or necessity may dictate, any of the 14 combinations of quantities as noted in Table III and representing possible problems involving these variables may be solved by suitable methods of computation.

### RELATION OF TYPE FORM OF PROPELLER TO THE PROBLEM OF DESIGN.

In most problems in design or of like practical character, the geometrical type form of the propeller is first assumed. Such assumption is, of course, only tentative, but it is usually convenient to carry on the program of search for a suitable design through trial of a series of selected type forms. In such case, with a type form chosen, the relation between the coefficients $C_1$, $C_2$, $C_3$, and $V/ND$ is immediately fixed, and, assuming it to be one of the 88 type forms covered by the present report, reference may be made directly to the corresponding diagram or table for values of the efficiency and of the coefficients $C_1$, $C_2$, $C_3$, as functions of $V/ND$. In any such case, then, an assumed value of the efficiency $\eta$ or of the function $V/ND$ will immediately determine the values of these coefficients and the solution will proceed along lines as indicated.

In certain cases, however (cases 7, 8, 9, Table III), the value of the coefficient may be left as an unknown, the various other quantities having been determined independent of any selected type form of propeller. The solution will then give the value of the coefficient $C_1$, $C_2$, $C_3$. This coefficient value may then be sought in the table or on the diagrams for various type forms. Wherever it is found it will at the same time determine a value of $x$, and hence of efficiency, and the value of the latter will naturally be a guide in the choice of the type form to be ultimately accepted. If no acceptable results in these respects can be found, it means naturally that suitable changes must be made in the basic data—as, for example, an increase or decrease in the diameter or in the revolutions or speed or some combination change in these basic data which will give a different value of the coefficient and thence perhaps a more acceptable efficiency.

In a similar manner, with other types of problems, as in Table III, the selected type form with the resultant value of $C$ may be such as to give an unacceptable result, especially in terms of $D$, $N$, or $V$. In such case, likewise, the basic assumptions must be modified in such manner as to give finally an acceptable combination of values.

### (3) NOMOGRAPHIC DIAGRAMS.

For the rapid graphical solution of problems such as those considered in the preceding section, nomographic diagrams have been prepared as in Plates I–VIII, the first four being in metric and the second four in English units. In the earlier reports, covering progressively the series of tests forming the subject of the present report, this feature was represented by the Eiffel logarithmic diagram, with curves showing values of $C_1$ for useful and effective power drawn thereon. This form of diagram, while furnishing a solution for all combinations of data involved in design problems, is, however, subject to two disadvantages:

(1) The operative program with reference to the sequence and direction of the vectors is not easy to carry in mind with only occasional use, and this fact has undoubtedly discouraged, in some measure, the use of this exceedingly ingenious form of graphical solution for design problems.

(2) Values are not infrequently determined by intersections of lines at rather acute angles, thus tending to magnify the probable error of construction.

For these reasons the nomographic form of diagram has been chosen in the present report. In diagrams of this type the operative program is simpler than in the Eiffel diagram, and the intersections may be made less acute. To cover all combinations of the data which may enter into such problems, however, four diagrams are required rather than one.

Thus, referring to the diagrams intended for metric units, Plates I, II, III are laid out for the use of equations (16), (17), (18), respectively, while Plate IV is provided for the solution of equation (19) or generally for connecting together the four quantities $x$, $V$, $N$, $D$.

Any discussion of the theory of nomographic diagrams or of the details of construction of such diagrams is beyond the scope of the present report. It will be desirable, however, to give some description of the diagrams as they are, together with suggestions regarding their use, and with such data as may be required should it be desired to reconstruct such diagrams on a larger scale or to extend the scale on any of the axes of the diagrams as given.

Referring to Plate I, the diagram is intended for the solution of the equation

$$gP = C_1 \Delta N^3 D^5$$

Attention may first be directed to the following points:

(1) The factor $g$ does not appear in the construction. It is "absorbed" in the program of development of the diagram. This remark applies equally to the diagrams of Plates II, III.

(2) The quantity $\Delta$ does not appear directly in the construction. Its place is taken by altitude $H$. This is simply a matter of the numbering of the graduations on this axis. The actual distance which is involved in the graphical construction is really $\Delta$ to a suitable unit, but the numbering on the scale represents the corresponding value of the altitude $H$. Thus the scales may be read directly in terms of altitude, while the density $\Delta$ is the quantity really employed in the computation. This remark applies equally to the diagrams of Plates II, III.

(3) The diagram contains axes, one each for the five quantities $P$, $C_1$, $H(\Delta)$, $N$, $D$, as noted, together with two auxiliary axes $Y_1$, $Y_2$.

(4) Let these be arranged in order as follows

$$D \quad H(\Delta) \quad N \quad Y_2 \quad Y_1 \quad C_1 \quad P$$

(5) These may then be taken in three successive groups of three each as follows (see also small key diagrams on plates):

$$\begin{matrix} H & Y_1 & C_1 \\ N & Y_2 & Y_1 \\ D & Y_2 & P \end{matrix}$$

(6) The solution consists, in effect, then, of drawing three straight lines across these three groups of axes, as in (5), in such manner as to contain the known data and to have common points on the auxiliary axes $Y_1$ and $Y_2$. One of these lines will then cut the axis of the unknown at the value required for the solution. (See also small key diagrams as above.)

(7) It should be especially noted that the seven axes are associated in three groups of three as above and in this way only.

(8) The following points regarding the units of Plates I, II, III, IV should be noted.

(a) The unit of $P$ is the metric horsepower direct and not the kilogram meter per second, as in the case of numerical computation.

(b) The unit of $N$ is one revolution per minute instead of per second, as in the case of numerical computation.

(c) The unit of $V$ is one kilometer per hour instead of one meter per second, as in the case of numerical computation.

These changes are made possible by suitable changes in the units used for the various scales of the axes of $P$, $V$, $N$, and thus permit the direct use of these quantities in terms of the common engineering units of measurement.

The scales on these diagrams, therefore, indicate as follows:

$V$ in kilometers per hour.
$N$ in r. p. m.
$D$ in meters.
$P$ in horsepower (metric).
$H$ in meters.
$C_1$, $C_2$, $C_3$, nondimensional.

ILLUSTRATIVE PROGRAMS.

Before noting a few illustrative programs, attention may be called to the following points:

The solution in each case will call for the determination of the unknowns as noted in the several cases of Table III, and this will require the use of two diagrams—viz, Plate IV and either Plates I, II, or III. The former will determine one of the four quantities $V$, $N$, $D$, or $x$ and the latter the remaining unknown.

The coefficients $C_1$, $C_2$, $C_3$ are dependent on $x = V/ND$ and may be determined from figures 19 to 52 or Table VIII as soon as $x$ is known.

In cases where $x$ is one of the knowns, the values of $C_1$, $C_2$, $C_3$ become known from figures 19 to 52 and Table VIII. In such cases the nomographic diagrams are to be used in such order as may be required by the details of the case—that is, Plate IV first and then Plate I, II, or III, or vice versa. (See cases 3, 4, 5, 10, 11, 12, 13, 14, 15, Table III.)

In cases where $x$ is one of the unknowns, its determination may fall under either of two programs:

(1) If the knowns include $V$, $N$, $D$, then $x$ is found immediately from the diagram of Plate IV. (See cases 1, 6, Table III.)

(2) If the knowns do not include $V$, $N$, $D$, they will include four quantities permitting the direct use of either Plate I, Plate II, or Plate III. This will give the value of $C_1$, $C_2$, or $C_3$, and this through figures 19 to 52 or Table VIII will give $x = V/ND$, and this through Plate IV will give the remaining unknown. (See cases 7, 8, 9, Table III.)

By way of illustration assume first case 1, Table III. The values $V$, $D$, $N$ serve immediately to determine $x$ or $V/ND$ by the diagram of Plate IV. A line is drawn through the values of $V$ and $D$, cutting $Y$. A second line is then drawn through $N$ and the point on $Y$. This line extended to the axis of $x$ or $V/ND$ will then give the value desired.

With $x$ known, we find from the suitable diagram of figures 19 to 52 or from Table VIII the value of $C_1$.

We have now as knowns all values involved in the diagram of Plate 1 except $P$. The triad groups are then as follows:

$$\begin{matrix} H & Y_1 & C_1 \\ N & Y_2 & Y_1 \\ D & Y_2 & (P) \end{matrix}$$

The line for the first triad being drawn, the point on $Y_1$ is determined. This point with $N$ serves to determine $Y_2$ in the second triad, and this point with $D$ serves to determine $P$ in the third triad, and thus the solution is completed.

Suppose with the same data it were chosen to use Plate 2. The program will proceed in entirely similar fashion. The value of $x$ is first found and then $C_2$. Then in Plate II the triad develop as follows:

$$\begin{array}{ccc} H & Y_1 & D \\ V & Y_2 & Y_1 \\ C_2 & Y_2 & (P) \end{array}$$

In an entirely similar manner Plate 3 may be used if desired.

Assume next the data of case 10, Table III. The values of $x$, $D$, $N$ being given, $V$ is found by Plate IV. The values of $C_1$, $C_2$, $C_3$ result immediately from $x$ through figures 19 to 52 and Table VIII. In case Plate I is employed, the triad groups result as follows:

$$\begin{array}{ccc} (H) & Y_1 & C_1 \\ N & Y_2 & Y_1 \\ D & Y_2 & P \end{array}$$

and $H$ is determined as the remaining unknown.

Assume again the data of case 7, Table III. The knowns $P$, $\Delta$, $D$, $N$ indicate Plate I as the only one available for this combination. The triad groups result as follows:

$$\begin{array}{ccc} H & Y_1 & (C_1) \\ N & Y_2 & Y_1 \\ D & Y_2 & P \end{array}$$

The value of $C_1$ thus results, and this gives, through figures 19 to 52 or Table VIII, the value of $x$, and thence through Plate IV we find V.

In all of these cases the value of the efficiency $\eta$ will naturally play an important part in determining the course of treatment of a design problem. This value follows immediately from $x$, through figs. 19 to 52 and Table VIII. In many cases $\eta$ will be assumed as a trial figure at some value which it is desired to realize if possible. Or otherwise the value of $x = V/ND$ will be assumed with primary reference to the corresponding value of the efficiency.

Diagrams of the nomographic type are especially well adapted to the purpose of indicating quickly the correlative changes in any two variables of either end triad, all other quantities remaining the same. Thus, a line in either end triad may be revolved about its $Y$ axis point without disturbing the remainder of the diagram. In this manner the correlative changes of either of these two pair of variables are readily examined.

Thus, in case (1), $V$, $N$, and $D$ are assumed known. The value of $x$ follows and thence $C_1$ and the solution proceeds, as previously indicated, to a resultant value of $P$. In this triad $P$ is associated with $D$. We may then tilt the line back and forth about the point on $Y_2$ as center and read off the values of $P$ for a series of diameters, *all other quantities on this diagram remaining the same.*

In order to realize the latter condition, however, it is clear that if $C_1$ is to remain the same with the same type of propeller, then $x = V/ND$ must remain the same, and hence ($N$ remaining the same) $V$ must be assumed to vary directly with the varying values of $D$. Thus if the $D$ be taken 10 per cent larger than the first value assumed, then the value of $P$ for a speed also 10 per cent greater at the same r. p. m. will be given by tilting the line about the intersection on $Y_2$ as indicated above.

Again in Plate IV, suppose that the value of $x$ is one which gives a value of the efficiency undesirably low. In this diagram $x$ is associated with $N$. We may then tilt the $xYN$ line about the $Y$ point as a center and note the relation between change in the r. p. m. and change in $x$ and hence change in efficiency, the ratio of $V$ to $D$ being supposed to remain the same.

Other similar applications of this convenient feature will occur to the interested reader.

It is apparent that in all of these various cases the solution may be carried on through equations (20), (21), (22), to include, if desired, values of useful power, thrust, and torque.

Nomographic diagrams might, of course, be prepared for the carrying out of the indicated computations, but their relatively lesser importance has not seemed to justify the extension of the present report to include the preparation of such diagrams.

While the preceding discussion of these diagrams has applied especially to those of Plates I–IV adapted to metric measures, the same general remarks apply equally well to those of Plates V–VIII adapted to English measures.

The scales of these indicate as follows:

$V$ in miles per hour.
$N$ in r. p. m.
$D$ in feet.
$P$ in horsepower.
$H$ in feet.
$C_1$, $C_2$, $C_3$ nondimensional as in Plates I–IV.

*Proportions and scales.*—A nomographic diagram such as that of Plate I for the solution of an equation such as (16) may be infinitely varied in proportion and in the scale units employed, all however, so related as to fulfill the basic conditions required for the solution. The particular proportions and scales employed in Plates I–VIII have been chosen primarily in such manner as to give a fairly equable distribution of axes over the diagram, combined with the ranges of values chosen for the different variables.

In case it should be desired to lay down any of these diagrams larger or smaller than those represented in plates I . . . VIII, or covering different ranges of values, the following method may be followed:

TABLE IV.—*Spacing of axes.*

PLATES.

| I, V. | II, VI. | III, VII. | IV, VIII. |
|---|---|---|---|
| $D$........ 0.000 | $C_2$........ 0.000 | $C_3$........ 0.000 | $X$........ 0.000 |
| $H$........ 1.977 | $H$........ 2.594 | $V$........ 2.740 | $V$........ 4.453 |
| $N$........ 4.440 | $V$........ 4.839 | $Y$........ 5.352 | $Y$........ 8.895 |
| $Y$........ 7.370 | $Y$........ 7.216 | $H$........ 9.830 | $D$........ 18.133 |
| $Y$........ 10.989 | $Y$........ 11.483 | $P$........ 13.444 | $N$........ 20.000 |
| $C_1$........ 15.299 | $D$........ 15.927 | $Y$........ 17.234 | |
| $P$........ 20.000 | $P$........ 20.000 | $N$........ 20.000 | |

The spacing of the successive axes is given in Table IV. In the originals from which Plates I . . . VIII were reproduced, the unit was 1 inch. This unit may be similarly taken at any value whatever, thus giving diagrams with spacings always in the same proportions as those of Plates I . . . VIII, but of any actual size as may be desired.

Next we must consider the mid values; that is, the values lying on a single continuous straight line drawn through the center of the field covered by the diagram. These values are given in Table V each in terms of the special unit appropriate to the quantity in question.

TABLE V.—*Mid values.*

PLATES.

| I. | V. | II. | VI. | III. | VII. | IV. | VIII. |
|---|---|---|---|---|---|---|---|
| $D$...... 2.8 | 9 | $C_2$...... 0.441 | 0.452 | $C_3$...... 1.969 | 2.006 | $X$...... 0.556 | 0.552 |
| $H$...... 4,600 | 15,100 | $H$...... 4,600 | 15,100 | $V$...... 124 | 77 | $V$...... 130 | 80 |
| $N$...... 1,500 | 1,500 | $V$...... 122 | 82 | $H$...... 4,600 | 15,100 | $D$...... 2.6 | 8.5 |
| $C_1$...... 0.0547 | 0.0615 | $D$...... 2.6 | 8.5 | $P$...... 160 | 160 | $N$...... 1,500 | 1,500 |
| $P$...... 154 | 154 | $P$...... 154 | 154 | $N$...... 1,500 | 1,500 | | |

Next, for the scale subdivisions, there is, for each axis, a factor $f$ as defined by the equation

$$a_2 - a_1 = f \log. a_2/a_1$$

where $(a_2 - a_1)$ = distance, in terms of any arbitrary unit, between graduations for values $a_2$ and $a_1$ $(a_2 > a_1)$.

These factors $f$ are given under the appropriate heading in Table VI. They are independent of the system of measures employed and are therefore the same for both metric and English measures. It will, of course, be understood that the unit of measure employed must be the same throughout any one diagram.

TABLE VI.—*Values of factors f.*

PLATES.

| I, V. | II, VI. | III, VII. | IV, VIII. |
|---|---|---|---|
| $D$ ........ 18.33 | $C$ ........ 3.030 | $C$ ........ 1.883 | $X$ ........ 9.353 |
| $H$ ........ 16.00 | $H$ ........ 16.000 | $V$ ........ 8.603 | $Y$ ........ 7.601 |
| $N$ ........ 12.570 | $V$ ........ 9.091 | $H$ ........ 16.000 | $D$ ........ 16.000 |
| $C$ ........ 7.651 | $D$ ........ 16.00 | $P$ ........ 5.33 | $N$ ........ 11.68 |
| $P$ ........ 6.285 | $P$ ........ 5.333 | $N$ ........ 11.43 | |

To fix the ideas, take Plate I, axis of D. The mid value is 2.8 (metric). The distance to the graduation for 2 (meters) will then be measured by 18.33 log. 1.4 = 2.678. This may then be laid down to any convenient unit, having in view the size of diagram permissible and the range of values desired.

If there should be reason for extending the diagram to include, say, values of 1 and 10, the distance from 2.8 to 1 would be measured by 18.33 log. 2.8 = 8.197, and, again, the distance from 1 to 0 would be measured by 18.33 log. 10 = 18.33.

Instead of using factors as given in Table VI with a unit adapted to the size of diagram desired, a fixed unit such as 1 cm. or 1 inch may be adopted, and we may multiply or divide the series of factors in Table VI by any coefficient at will, thus giving various series of numbers, but always in the proportion of those in the table.

Thus, by way of illustration, in Plate I, axis D, the total range is from about 1.875 to about 4.182. The log. of the ratio of these two numbers is 0.3483, and with a unit of 1 cm. and the factor 18.33 as in Table VI the total length of this axis would equal 6.384 cm. By taking a unit of 5 cm. or otherwise by using a factor $5 \times 18.33 = 91.65$, the over-all length would become 31.92 cm.

In this manner, then, the graduations on any axis may be laid out according to convenience. Obviously the same unit must be used throughout for any one diagram.

If for any reason it should be desired to subdivide the graduations on Plates I . . . VIII as printed, or to extend them to somewhat higher or lower limits, the following steps may be taken:

(1) Measure with scale the linear distance between two convenient numbers such as 1 and 5 or 1 and 10 or any other convenient pair, taking them, however, in such manner as to include a considerable part of the scale length.

(2) Take the log. of the ratio of the two numbers and divide it into the distance.

The quotient will establish the factor $f$ for the particular unit of measure employed and for the plate as actually printed. This factor $f$ may then be used in manner as indicated above to determine the distance between the graduations for any two numbers on the scale as desired.

The scales for altitude require somewhat different treatment.

TABLE VII.—*Relation between altitude and density.*

| Altitude (meters). | Kg. per cubic meter. | Altitude (feet). | Pounds per cubic foot. |
|---|---|---|---|
| 000 | 1.214 | 000 | 0.0758 |
| 500 | 1.155 | 1,000 | .0736 |
| 1,000 | 1.099 | 2,000 | .0713 |
| 1,500 | 1.045 | 3,000 | .0691 |
| 2,000 | .995 | 4,000 | .0671 |
| 2,500 | .945 | 5,000 | .0651 |
| 3,000 | .901 | 6,000 | .0631 |
| 3,500 | .857 | 7,000 | .0613 |
| 4,000 | .815 | 8,000 | .0595 |
| 4,500 | .776 | 9,000 | .0576 |
| 5,000 | .738 | 10,000 | .0559 |
| 5,500 | .702 | 11,000 | .0543 |
| 6,000 | .669 | 12,000 | .0527 |
| 6,500 | .637 | 13,000 | .0511 |
| 7,000 | .608 | 14,000 | .0497 |
| 7,500 | .580 | 15,000 | .0481 |
| 8,000 | .553 | 16,000 | .0467 |
| 8,500 | .529 | 17,000 | .0453 |
| 9,000 | .506 | 18,000 | .0442 |
| | | 19,000 | .0428 |
| | | 20,000 | .0415 |
| | | 21,000 | .0402 |
| | | 22,000 | .0390 |
| | | 23,000 | .0379 |
| | | 24,000 | .0368 |
| | | 25,000 | .0358 |
| | | 26,000 | .0348 |
| | | 27,000 | .0338 |
| | | 28,000 | .0328 |
| | | 29,000 | .0318 |
| | | 30,000 | .0309 |

Table VII gives the relations employed between altitude and density in both metric and English measures.

As previously noted, the actual quantity involved in the computation is density $\Delta$, but for convenience this is represented on the diagram by altitude $H$. The factor $f$ as given in Table VI is for density. Hence, in order to determine the distance between the graduations for any two values of the altitude, we may proceed as follows:

(1) Convert the two values of $H$ into values of $\Delta$ through Table VII by interpolation, or graphically by curves plotted from these tables.

(2) Then divide the larger value of $\Delta$ by the smaller, find the log. of the ratio, multiply by the factor $f$, and the product will give the distance desired.

TABLE VIII.

PROPELLER NO. 1.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0919 | 11.49 | 257.3 | 0.343 |
| .25 | .0928 | 5.940 | 95.03 | .414 |
| .30 | .0940 | 3.482 | 38.70 | .479 |
| .35 | .0949 | 2.213 | 18.06 | .537 |
| .40 | .0952 | 1.487 | 9.296 | .585 |
| .45 | .0948 | 1.040 | 5.138 | .629 |
| .50 | .0938 | .7506 | 3.002 | .667 |
| .55 | .0920 | .5530 | 1.828 | .701 |
| .60 | .0895 | .4144 | 1.151 | .729 |
| .65 | .0863 | .3143 | .7440 | .753 |
| .70 | .0825 | .2405 | .4909 | .770 |
| .75 | .0783 | .1856 | .3300 | .782 |
| .80 | .0737 | .1440 | .2250 | .788 |
| .85 | .0685 | .1115 | .1548 | .788 |
| .90 | .0630 | .0864 | .1067 | .780 |
| .95 | .0570 | .0663 | .0737 | .760 |

PROPELLER NO. 2.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.1065 | 13.31 | 332.8 | 0.332 |
| .25 | .1067 | 6.828 | 109.3 | .404 |
| .30 | .1068 | 3.953 | 43.96 | .472 |
| .35 | .1066 | 2.434 | 20.28 | .533 |
| .40 | .1057 | 1.661 | 10.32 | .585 |
| .45 | .1045 | 1.147 | 5.665 | .632 |
| .50 | .1024 | .8192 | 3.277 | .674 |
| .55 | .0991 | .5947 | 1.969 | .708 |
| .60 | .0950 | .4393 | 1.232 | .736 |
| .65 | .0901 | .3252 | .7769 | .759 |
| .70 | .0847 | .2470 | .5040 | .774 |
| .75 | .0788 | .1863 | .3321 | .781 |
| .80 | .0725 | .1416 | .2212 | .781 |
| .85 | .0660 | .1075 | .1458 | .775 |
| .90 | .0593 | .0813 | .1004 | .757 |
| .95 | .0525 | .0613 | .0679 | .717 |

TABLE VIII—Continued.

PROPELLER NO. 3.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0848 | 10.60 | 265.0 | 0.353 |
| .25 | .0859 | 5.50 | 87.97 | .425 |
| .30 | .0870 | 3.222 | 35.80 | .487 |
| .35 | .0877 | 2.046 | 16.70 | .544 |
| .40 | .0880 | 1.375 | 8.594 | .594 |
| .45 | .0879 | .9648 | 4.764 | .638 |
| .50 | .0872 | .6976 | 2.791 | .679 |
| .55 | .0860 | .5168 | 1.709 | .713 |
| .60 | .0845 | .3912 | 1.087 | .744 |
| .65 | .0825 | .3004 | .7112 | .768 |
| .70 | .0802 | .2338 | .4772 | .788 |
| .75 | .0770 | .1825 | .3244 | .803 |
| .80 | .0733 | .1432 | .2238 | .809 |
| .85 | .0684 | .1114 | .1542 | .809 |
| .90 | .0629 | .0863 | .1065 | .805 |
| .95 | .0565 | .0659 | .0730 | .786 |
| 1.00 | .0498 | .0498 | .0498 | .752 |

PROPELLER NO. 4.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.25 | 0.1032 | 6.605 | 105.7 | 0.410 |
| .30 | .1035 | 3.833 | 42.59 | .476 |
| .35 | .1035 | 2.414 | 19.71 | .532 |
| .40 | .1030 | 1.609 | 10.05 | .583 |
| .45 | .1015 | 1.114 | 5.502 | .629 |
| .50 | .0994 | .7953 | 3.182 | .668 |
| .55 | .0962 | .5735 | 1.913 | .704 |
| .60 | .0927 | .4292 | 1.192 | .734 |
| .65 | .0885 | .3237 | .7639 | .759 |
| .70 | .0841 | .2452 | .5004 | .778 |
| .75 | .0790 | .1873 | .3330 | .704 |
| .80 | .0732 | .1430 | .2234 | .797 |
| .85 | .0666 | .1083 | .1499 | .786 |
| .90 | .0590 | .0809 | .0999 | .761 |

PROPELLER No. 5.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0710 | 8.875 | 221.9 | 0.383 |
| .25 | .0713 | 4.563 | 73.02 | .461 |
| .30 | .0712 | 2.637 | 29.30 | .526 |
| .35 | .0706 | 1.6515 | 13.48 | .583 |
| .40 | .0698 | 1.091 | 6.819 | .630 |
| .45 | .0681 | .7497 | 3.702 | .670 |
| .50 | .0661 | .5289 | 2.116 | .702 |
| .55 | .0633 | .3806 | 1.258 | .726 |
| .60 | .0601 | .2763 | .7728 | .745 |
| .65 | .0566 | .2061 | .4879 | .753 |
| .70 | .0526 | .1534 | .3131 | .743 |
| .75 | .0485 | .1150 | .2045 | .712 |

PROPELLER No. 6.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0771 | 9.638 | 241.0 | 0.382 |
| .25 | .0762 | 4.877 | 78.05 | .451 |
| .30 | .0750 | 2.778 | 30.87 | .530 |
| .35 | .0736 | 1.717 | 14.02 | .586 |
| .40 | .0717 | 1.1205 | 7.003 | .635 |
| .45 | .0690 | .7574 | 3.740 | .676 |
| .50 | .0655 | .5241 | 2.096 | .710 |
| .55 | .0615 | .3696 | 1.229 | .733 |
| .60 | .0569 | .2634 | .7315 | .744 |
| .65 | .0520 | .1894 | .4453 | .736 |
| .70 | .0466 | .1359 | .2773 | .705 |

PROPELLER No. 7.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0682 | 8.525 | 213.1 | 0.395 |
| .25 | .0686 | 4.391 | 70.26 | .473 |
| .30 | .0686 | 2.541 | 28.24 | .538 |
| .35 | .0680 | 1.586 | 12.95 | .597 |
| .40 | .0667 | 1.042 | 6.513 | .650 |
| .45 | .0649 | .7128 | 3.518 | .695 |
| .50 | .0626 | .5009 | 2.004 | .730 |
| .55 | .0600 | .3606 | 1.192 | .755 |
| .60 | .0568 | .2630 | .7306 | .772 |
| .65 | .0534 | .1945 | .4604 | .778 |
| .70 | .0494 | .1440 | .2939 | .767 |
| .75 | .0453 | .1074 | .1910 | .737 |

PROPELLER No. 8.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0733 | 9.163 | 229.1 | 0.385 |
| .25 | .0726 | 4.647 | 74.36 | .463 |
| .30 | .0717 | 2.655 | 29.50 | .528 |
| .35 | .0700 | 1.633 | 13.33 | .590 |
| .40 | .0677 | 1.058 | 6.612 | .634 |
| .45 | .0645 | .7080 | 3.496 | .675 |
| .50 | .0605 | .4840 | 1.936 | .708 |
| .55 | .0564 | .3300 | 1.120 | .736 |
| .60 | .0517 | .2393 | .6647 | .755 |
| .65 | .0470 | .1712 | .4052 | .757 |
| .70 | .0421 | .1228 | .2506 | .734 |
| .75 | .0366 | .0867 | .1542 | .679 |

PROPELLER No. 9.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0455 | 5.688 | 142.2 | 0.419 |
| .25 | .0449 | 2.874 | 45.98 | .496 |
| .30 | .0439 | 1.626 | 18.07 | .561 |
| .35 | .0423 | .9868 | 8.056 | .619 |
| .40 | .0405 | .6328 | 3.955 | .659 |
| .45 | .0383 | .4204 | 2.076 | .688 |
| .50 | .0359 | .2872 | 1.149 | .684 |
| .55 | .0335 | .2013 | .6654 | .657 |
| .60 | .0310 | .1435 | .3986 | .588 |
| .65 | .0283 | .1030 | .2438 | .469 |

PROPELLER No. 10.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0487 | 6.087 | 152.2 | 0.421 |
| .25 | .0478 | 3.027 | 48.44 | .505 |
| .30 | .0458 | 1.696 | 18.85 | .572 |
| .35 | .0437 | 1.019 | 8.322 | .628 |
| .40 | .0409 | .6390 | 3.994 | .657 |
| .45 | .0376 | .4127 | 2.038 | .670 |
| .50 | .0337 | .2696 | 1.078 | .659 |
| .55 | .0293 | .1761 | .582 | .614 |

PROPELLER No. 11.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0451 | 5.638 | 141.0 | 0.434 |
| .25 | .0446 | 2.855 | 45.67 | .522 |
| .30 | .0440 | 1.630 | 18.11 | .590 |
| .35 | .0429 | 1.000 | 8.164 | .644 |
| .40 | .0417 | .6515 | 4.073 | .683 |
| .45 | .0400 | .4390 | 2.168 | .704 |
| .50 | .0378 | .3024 | 1.210 | .707 |
| .55 | .0350 | .2104 | .6954 | .693 |
| .60 | .0319 | .1477 | .4103 | .644 |

PROPELLER NO. 12.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0471 | 5.888 | 147.2 | 0.426 |
| .25 | .0464 | 2.970 | 47.52 | .506 |
| .30 | .0453 | 1.678 | 18.64 | .571 |
| .35 | .0438 | 1.017 | 8.302 | .622 |
| .40 | .0412 | .6437 | 4.023 | .655 |
| .45 | .0379 | .4160 | 2.055 | .669 |
| .50 | .0340 | .2720 | 1.088 | .665 |
| .55 | .0297 | .1785 | .590 | .623 |

TABLE VIII—Continued.

PROPELLER NO. 13.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0907 | 11.34 | 283.5 | 0.331 |
| .25 | .0920 | 5.889 | 94.24 | .404 |
| .30 | .0926 | 3.437 | 38.19 | .469 |
| .35 | .0933 | 2.176 | 17.76 | .537 |
| .40 | .0934 | 1.459 | 9.120 | .580 |
| .45 | .0930 | 1.021 | 5.042 | .626 |
| .50 | .0916 | .7329 | 2.982 | .669 |
| .55 | .0895 | .5390 | 1.778 | .705 |
| .60 | .0867 | .4014 | 1.115 | .736 |
| .65 | .0835 | .3041 | .7197 | .760 |
| .70 | .0795 | .2318 | .4731 | .779 |
| .75 | .0754 | .1787 | .3177 | .791 |
| .80 | .0708 | .1383 | .2161 | .796 |
| .85 | .0660 | .1075 | .1458 | .795 |
| .90 | .0610 | .0837 | .1033 | .779 |
| .95 | .0557 | .0650 | .0720 | .745 |

PROPELLER NO. 14.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.25 | 0.1100 | 7.041 | 112.7 | 0.402 |
| .30 | .1100 | 4.073 | 45.26 | .466 |
| .35 | .1097 | 2.559 | 20.89 | .524 |
| .40 | .1085 | 1.695 | 10.60 | .575 |
| .45 | .1065 | 1.160 | 5.773 | .620 |
| .50 | .1041 | .8329 | 3.332 | .660 |
| .55 | .1007 | .6053 | 2.001 | .698 |
| .60 | .0966 | .4472 | 1.242 | .730 |
| .65 | .0916 | .3336 | .7896 | .757 |
| .70 | .0860 | .2508 | .5119 | .775 |
| .75 | .0797 | .1889 | .3558 | .784 |
| .80 | .0731 | .1428 | .2281 | .786 |
| .85 | .0662 | .1078 | .1492 | .778 |
| .90 | .0586 | .0804 | .0993 | .750 |
| .95 | .0507 | .0591 | .0655 | .704 |

PROPELLER NO. 15.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0867 | 10.71 | 267.8 | 0.341 |
| .25 | .0871 | 5.575 | 89.21 | .413 |
| .30 | .0888 | 3.289 | 36.55 | .475 |
| .35 | .0900 | 2.099 | 17.14 | .531 |
| .40 | .0908 | 1.419 | 8.870 | .586 |
| .45 | .0910 | .9933 | 4.933 | .638 |
| .50 | .0902 | .7217 | 2.887 | .684 |
| .55 | .0887 | .5332 | 1.763 | .720 |
| .60 | .0865 | .4005 | 1.112 | .749 |
| .65 | .0836 | .3045 | .7206 | .771 |
| .70 | .0800 | .2333 | .4761 | .787 |
| .75 | .0761 | .1804 | .3207 | .799 |
| .80 | .0719 | .1404 | .2194 | .804 |
| .85 | .0671 | .1093 | .1512 | .802 |
| .90 | .0622 | .0853 | .1063 | .790 |
| .95 | .0570 | .0665 | .0737 | .761 |

PROPELLER NO. 16.

| | | | | |
|---|---|---|---|---|
| 0.25 | 0.1029 | 6.585 | 105.4 | 0.417 |
| .30 | .1030 | 3.814 | 42.38 | .478 |
| .35 | .1026 | 2.393 | 19.54 | .535 |
| .40 | .1016 | 1.587 | 9.920 | .587 |
| .45 | .1000 | 1.097 | 5.418 | .632 |
| .50 | .0979 | .7833 | 3.133 | .678 |
| .55 | .0950 | .5710 | 1.888 | .711 |
| .60 | .0915 | .4286 | 1.177 | .745 |
| .65 | .0876 | .3190 | .7550 | .772 |
| .70 | .0829 | .2417 | .4933 | .791 |
| .75 | .0775 | .1837 | .3266 | .801 |
| .80 | .0717 | .1400 | .2187 | .803 |
| .85 | .0648 | .1055 | .1460 | .795 |
| .90 | .0570 | .0782 | .0965 | .774 |
| .95 | .0434 | .0565 | .0626 | .731 |

PROPELLER NO. 17.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0695 | 8.563 | 214.1 | 0.374 |
| .25 | .0697 | 4.397 | 70.36 | .458 |
| .30 | .0695 | 2.537 | 28.19 | .520 |
| .35 | .0680 | 1.586 | 12.95 | .578 |
| .40 | .0664 | 1.037 | 6.484 | .628 |
| .45 | .0642 | .7047 | 3.480 | .670 |
| .50 | .0613 | .4905 | 1.962 | .710 |
| .55 | .0581 | .3492 | 1.154 | .740 |
| .60 | .0545 | .2528 | .7010 | .761 |
| .65 | .0506 | .1843 | .4362 | .769 |
| .70 | .0465 | .1356 | .2767 | .759 |
| .75 | .0422 | .1000 | .1778 | .725 |

PROPELLER NO. 18.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0742 | 9.275 | 231.9 | 0.370 |
| .25 | .0738 | 4.724 | 75.58 | .443 |
| .30 | .0727 | 2.693 | 29.92 | .515 |
| .35 | .0706 | 1.647 | 13.45 | .576 |
| .40 | .0680 | 1.063 | 6.644 | .630 |
| .45 | .0647 | .7102 | 3.507 | .677 |
| .50 | .0607 | .4857 | 1.943 | .717 |
| .55 | .0564 | .3390 | 1.121 | .748 |
| .60 | .0517 | .2393 | .6647 | .762 |
| .65 | .0469 | .1706 | .4042 | .758 |
| .70 | .0418 | .1219 | .2453 | .728 |

PROPELLER NO. 19.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0614 | 7.675 | 191.9 | 0.334 |
| .25 | .0611 | 3.911 | 62.58 | .462 |
| .30 | .0609 | 2.255 | 25.06 | .531 |
| .35 | .0601 | 1.402 | 11.45 | .593 |
| .40 | .0589 | .9203 | 5.752 | .647 |
| .45 | .0574 | .6300 | 3.111 | .694 |
| .50 | .0555 | .4440 | 1.776 | .730 |
| .55 | .0532 | .3198 | 1.057 | .759 |
| .60 | .0504 | .2333 | .6480 | .777 |
| .65 | .0474 | .1726 | .4085 | .772 |
| .70 | .0437 | .1274 | .2600 | .733 |

PROPELLER NO. 20.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0761 | 9.514 | 237.8 | 0.383 |
| .25 | .0754 | 4.826 | 77.22 | .455 |
| .30 | .0742 | 2.748 | 30.53 | .519 |
| .35 | .0724 | 1.689 | 13.79 | .577 |
| .40 | .0701 | 1.095 | 6.844 | .629 |
| .45 | .0674 | .7296 | 3.654 | .674 |
| .50 | .0639 | .5112 | 2.046 | .714 |
| .55 | .0600 | .3606 | 1.192 | .745 |
| .60 | .0556 | .2574 | .7150 | .765 |
| .65 | .0506 | .1850 | .4378 | .772 |
| .70 | .0454 | .1324 | .2702 | .757 |
| .75 | .0391 | .0927 | .1648 | .713 |

PROPELLER NO. 21.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0456 | 5.700 | 142.5 | 0.413 |
| .25 | .0455 | 2.912 | 46.59 | .495 |
| .30 | .0444 | 1.644 | 18.27 | .563 |
| .35 | .0425 | .9914 | 8.094 | .620 |
| .40 | .0402 | .6281 | 3.926 | .664 |
| .45 | .0375 | .4115 | 2.033 | .697 |
| .50 | .0346 | .2763 | 1.107 | .704 |
| .55 | .0317 | .1905 | .6297 | .678 |
| .60 | .0286 | .1324 | .3675 | .613 |

PROPELLER NO. 22.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0479 | 5.988 | 149.7 | 0.412 |
| .25 | .0472 | 3.021 | 48.34 | .490 |
| .30 | .0455 | 1.685 | 18.72 | .556 |
| .35 | .0433 | 1.010 | 8.245 | .606 |
| .40 | .0408 | .6297 | 3.936 | .643 |
| .45 | .0369 | .4050 | 2.000 | .660 |
| .50 | .0331 | .2643 | 1.069 | .641 |
| .55 | .0290 | .1743 | .5761 | .583 |

TABLE VIII—Continued.

PROPELLER NO. 23.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0413 | 5.163 | 120.1 | 0.425 |
| .25 | .0410 | 2.624 | 41.99 | .507 |
| .30 | .0403 | 1.493 | 16.89 | .577 |
| .35 | .0390 | .9096 | 7.426 | .633 |
| .40 | .0373 | .5828 | 3.643 | .673 |
| .45 | .0356 | .3907 | 1.930 | .695 |
| .50 | .0335 | .2680 | 1.072 | .698 |
| .55 | .0311 | .1869 | .6178 | .671 |
| .60 | .0283 | .1310 | .3639 | .610 |

PROPELLER NO. 24.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0454 | 5.675 | 141.9 | 0.429 |
| .25 | .0144 | 2.842 | 45.47 | .510 |
| .30 | .0427 | 1.581 | 17.57 | .576 |
| .35 | .0404 | .9424 | 7.692 | .626 |
| .40 | .0378 | .5906 | 3.691 | .653 |
| .45 | .0345 | .3787 | 1.870 | .679 |
| .50 | .0310 | .2480 | .9920 | .671 |
| .55 | .0271 | .1629 | .5354 | .616 |

PROPELLER NO. 25.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.25 | 0.1123 | 7.187 | 115.0 | 0.370 |
| .30 | .1140 | 4.222 | 46.93 | .433 |
| .35 | .1157 | 2.699 | 22.04 | .494 |
| .40 | .1168 | 1.825 | 11.41 | .546 |
| .45 | .1169 | 1.283 | 6.336 | .594 |
| .50 | .1162 | .9296 | 3.718 | .636 |
| .55 | .1148 | .6900 | 2.281 | .672 |
| .60 | .1126 | .5213 | 1.448 | .701 |
| .65 | .1099 | .4002 | .9473 | .727 |
| .70 | .1066 | .3108 | .6343 | .744 |
| .75 | .1026 | .2432 | .4324 | .753 |
| .80 | .0981 | .1916 | .2994 | .755 |
| .85 | .0930 | .1514 | .2095 | .749 |
| .90 | .0872 | .1196 | .1477 | .735 |
| .95 | .0806 | .0940 | .1042 | .705 |

PROPELLER NO. 26.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.25 | 0.1182 | 7.565 | 121.05 | 0.390 |
| .30 | .1183 | 4.382 | 48.69 | .455 |
| .35 | .1181 | 2.755 | 22.49 | .514 |
| .40 | .1176 | 1.837 | 11.48 | .564 |
| .45 | .1163 | 1.276 | 6.304 | .610 |
| .50 | .1137 | .9097 | 3.639 | .651 |
| .55 | .1108 | .6620 | 2.192 | .685 |
| .60 | .1065 | .4931 | 1.370 | .716 |
| .65 | .1020 | .3715 | .8792 | .740 |
| .70 | .0973 | .2837 | .5790 | .758 |
| .75 | .0919 | .2178 | .3872 | .763 |
| .80 | .0859 | .1678 | .2622 | .769 |
| .85 | .0798 | .1300 | .1799 | .742 |
| .90 | .0731 | .1003 | .1238 | .706 |

PROPELLER NO. 27.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.25 | 0.0990 | 6.336 | 101.4 | 0.415 |
| .30 | .1004 | 3.718 | 41.31 | .478 |
| .35 | .1016 | 2.370 | 19.35 | .530 |
| .40 | .1027 | 1.605 | 10.03 | .578 |
| .45 | .1033 | 1.134 | 5.600 | .620 |
| .50 | .1033 | .8265 | 3.306 | .659 |
| .55 | .1022 | .6143 | 2.031 | .691 |
| .60 | .1003 | .4644 | 1.290 | .719 |
| .65 | .0975 | .3551 | .8405 | .741 |
| .70 | .0940 | .2741 | .5594 | .759 |
| .75 | .0900 | .2133 | .3792 | .769 |
| .80 | .0854 | .1663 | .2606 | .772 |
| .85 | .0804 | .1309 | .1812 | .767 |
| .90 | .0751 | .1030 | .1272 | .748 |
| .95 | .0691 | .0806 | .0898 | .707 |

PROPELLER NO. 28.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.25 | 0.1105 | 7.072 | 113.17 | 0.403 |
| .30 | .1121 | 4.152 | 46.13 | .463 |
| .35 | .1134 | 2.645 | 20.76 | .517 |
| .40 | .1140 | 1.781 | 11.13 | .565 |
| .45 | .1137 | 1.248 | 6.164 | .606 |
| .50 | .1124 | .8993 | 3.597 | .648 |
| .55 | .1103 | .6630 | 2.192 | .683 |
| .60 | .1075 | .4976 | 1.392 | .718 |
| .65 | .1037 | .3777 | .8930 | .741 |
| .70 | .0988 | .2881 | .5880 | .763 |
| .75 | .0929 | .2202 | .3915 | .778 |
| .80 | .0863 | .1696 | .2634 | .783 |
| .85 | .0795 | .1295 | .1792 | .774 |
| .90 | .0724 | .0993 | .1236 | .741 |

PROPELLER NO. 29.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0873 | 10.91 | 272.8 | 0.348 |
| .25 | .0890 | 5.696 | 91.14 | .424 |
| .30 | .0901 | 3.337 | 37.08 | .492 |
| .35 | .0906 | 2.113 | 17.25 | .551 |
| .40 | .0904 | 1.4125 | 8.828 | .600 |
| .45 | .0888 | .9747 | 4.818 | .644 |
| .50 | .0861 | .6889 | 2.756 | .676 |
| .55 | .0826 | .4965 | 1.641 | .700 |
| .60 | .0783 | .3625 | 1.007 | .714 |
| .65 | .0740 | .2695 | .6378 | .717 |
| .70 | .0695 | .2027 | .4137 | .709 |
| .75 | .0648 | .1536 | .2731 | .680 |

PROPELLER NO. 30.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0869 | 10.86 | 271.5 | 0.365 |
| .25 | .0864 | 5.530 | 88.49 | .433 |
| .30 | .0857 | 3.174 | 35.27 | .496 |
| .35 | .0845 | 1.971 | 16.09 | .553 |
| .40 | .0826 | 1.291 | 8.069 | .602 |
| .45 | .0797 | .8748 | 4.320 | .645 |
| .50 | .0759 | .6073 | 2.429 | .680 |
| .55 | .0713 | .4285 | 1.416 | .706 |
| .60 | .0665 | .3079 | .8554 | .721 |
| .65 | .0614 | .2236 | .5292 | .719 |
| .70 | .0560 | .1633 | .3333 | .691 |

PROPELLER NO. 31.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0783 | 9.788 | 244.7 | 0.371 |
| .25 | .0792 | 5.069 | 81.11 | .448 |
| .30 | .0799 | 2.959 | 32.88 | .509 |
| .35 | .0799 | 1.864 | 15.22 | .561 |
| .40 | .0791 | 1.236 | 7.725 | .607 |
| .45 | .0776 | .8518 | 4.207 | .649 |
| .50 | .0754 | .6033 | 2.413 | .684 |
| .55 | .0725 | .4358 | 1.441 | .715 |
| .60 | .0689 | .3190 | .8861 | .734 |
| .65 | .0650 | .2367 | .5602 | .738 |
| .70 | .0604 | .1761 | .3594 | .727 |
| .75 | .0556 | .1318 | .2343 | .695 |
| .80 | .0505 | .0986 | .1541 | .641 |

PROPELLER NO. 32.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0828 | 10.35 | 258.8 | 0.367 |
| .25 | .0836 | 5.364 | 85.83 | .440 |
| .30 | .0844 | 3.126 | 34.73 | .504 |
| .35 | .0841 | 1.962 | 16.02 | .560 |
| .40 | .0825 | 1.289 | 8.056 | .610 |
| .45 | .0797 | .8748 | 4.320 | .655 |
| .50 | .0760 | .6081 | 2.432 | .694 |
| .55 | .0716 | .4303 | 1.422 | .722 |
| .60 | .0670 | .3102 | .8618 | .739 |
| .65 | .0621 | .2261 | .5351 | .737 |
| .70 | .0571 | .1665 | .3396 | .701 |

TABLE VIII—Continued.

PROPELLER NO. 33.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0579 | 7.238 | 180.95 | 0.397 |
| .25 | .0589 | 3.770 | 60.32 | .473 |
| .30 | .0588 | 2.178 | 24.20 | .536 |
| .35 | .0577 | 1.346 | 10.99 | .585 |
| .40 | .0560 | .8750 | 5.469 | .620 |
| .45 | .0534 | .5861 | 2.895 | .634 |
| .50 | .0503 | .4025 | 1.610 | .631 |
| .55 | .0463 | .2813 | .9298 | .605 |
| .60 | .0428 | .1981 | .5504 | .544 |

PROPELLER NO. 34.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0540 | 6.750 | 168.8 | 0.410 |
| .25 | .0535 | 3.424 | 54.79 | .479 |
| .30 | .0524 | 1.941 | 21.57 | .537 |
| .35 | .0506 | 1.180 | 9.633 | .580 |
| .40 | .0478 | .7463 | 4.669 | .608 |
| .45 | .0442 | .4851 | 2.396 | .612 |
| .50 | .0401 | .3209 | 1.284 | .590 |
| .55 | .0353 | .2152 | .7113 | .537 |

PROPELLER No. 35.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0557 | 6.963 | 174.1 | 0.404 |
| .25 | .0560 | 3.584 | 57.34 | .481 |
| .30 | .0560 | 2.074 | 23.04 | .541 |
| .35 | .0550 | 1.283 | 10.47 | .581 |
| .40 | .0531 | .8297 | 5.186 | .627 |
| .45 | .0505 | .5542 | 2.737 | .645 |
| .50 | .0477 | .3817 | 1.527 | .643 |
| .55 | .0447 | .2687 | .8881 | .612 |

PROPELLER No. 36.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0580 | 7.250 | 181.2 | 0.400 |
| .25 | .0579 | 3.706 | 59.30 | .471 |
| .30 | .0571 | 2.115 | 23.50 | .531 |
| .35 | .0554 | 1.292 | 10.55 | .576 |
| .40 | .0534 | .8188 | 5.117 | .613 |
| .45 | .0493 | .5568 | 2.645 | .628 |
| .50 | .0446 | .3869 | 1.423 | .622 |
| .55 | .0398 | .2392 | .7907 | .581 |

PROPELLER No. 37.

| | | | | |
|---|---|---|---|---|
| 0.25 | 0.1130 | 7.232 | 115.7 | 0.371 |
| .30 | .1152 | 4.257 | 47.41 | .432 |
| .35 | .1179 | 2.750 | 22.45 | .490 |
| .40 | .1188 | 1.853 | 11.58 | .544 |
| .45 | .1178 | 1.293 | 6.385 | .593 |
| .50 | .1157 | .9257 | 3.703 | .635 |
| .55 | .1130 | .6792 | 2.245 | .672 |
| .60 | .1092 | .5058 | 1.404 | .702 |
| .65 | .1051 | .3827 | .9058 | .728 |
| .70 | .1007 | .2936 | .5992 | .745 |
| .75 | .0954 | .2262 | .4021 | .757 |
| .80 | .0898 | .1754 | .2741 | .761 |
| .85 | .0829 | .1366 | .1891 | .757 |
| .90 | .0777 | .1066 | .1316 | .741 |
| .95 | .0712 | .0831 | .0921 | .710 |

PROPELLER No. 38.

| | | | | |
|---|---|---|---|---|
| 0.25 | 0.1190 | 7.674 | 122.8 | 0.350 |
| .30 | .1217 | 4.507 | 50.08 | .445 |
| .35 | .1222 | 2.853 | 23.29 | .506 |
| .40 | .1212 | 1.894 | 11.84 | .560 |
| .45 | .1189 | 1.305 | 6.445 | .610 |
| .50 | .1155 | .9240 | 3.696 | .652 |
| .55 | .1118 | .6690 | 2.212 | .689 |
| .60 | .1064 | .4926 | 1.368 | .721 |
| .65 | .1009 | .3675 | .8693 | .745 |
| .70 | .0949 | .2767 | .5647 | .760 |
| .75 | .0885 | .2093 | .3730 | .761 |
| .80 | .0818 | .1598 | .2497 | .747 |
| .85 | .0747 | .1217 | .1634 | .717 |

PROPELLER No. 39.

| | | | | |
|---|---|---|---|---|
| 0.25 | 0.0996 | 6.875 | 102.0 | 0.414 |
| .30 | .1011 | 3.745 | 41.61 | .478 |
| .35 | .1027 | 2.395 | 19.56 | .533 |
| .40 | .1039 | 1.623 | 10.14 | .582 |
| .45 | .1043 | 1.145 | 5.655 | .625 |
| .50 | .1039 | .8312 | 3.325 | .661 |
| .55 | .1028 | .6179 | 2.043 | .692 |
| .60 | .1013 | .4690 | 1.303 | .720 |
| .65 | .0990 | .3605 | .8532 | .741 |
| .70 | .0960 | .2799 | .5713 | .757 |
| .75 | .0920 | .2181 | .3877 | .769 |
| .80 | .0874 | .1707 | .2667 | .770 |
| .85 | .0821 | .1337 | .1850 | .764 |
| .90 | .0764 | .1043 | .1294 | .740 |
| .95 | .0702 | .0819 | .0907 | .699 |

PROPELLER No. 40.

| | | | | |
|---|---|---|---|---|
| 0.25 | 0.1139 | 7.290 | 116.6 | 0.339 |
| .30 | .1151 | 4.263 | 47.36 | .453 |
| .35 | .1163 | 2.713 | 22.15 | .510 |
| .40 | .1161 | 1.814 | 11.34 | .561 |
| .45 | .1143 | 1.260 | 6.223 | .607 |
| .50 | .1125 | .9000 | 3.600 | .650 |
| .55 | .1091 | .6568 | 2.163 | .685 |
| .60 | .1050 | .4861 | 1.628 | .718 |
| .65 | .1000 | .3642 | .8620 | .741 |
| .70 | .0945 | .2755 | .5623 | .759 |
| .75 | .0885 | .2093 | .3730 | .766 |
| .80 | .0821 | .1604 | .2505 | .765 |
| .85 | .0757 | .1233 | .1707 | .753 |
| .90 | .0683 | .0944 | .1165 | .722 |

PROPELLER No. 41.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0866 | 10.827 | 270.6 | 0.347 |
| .25 | .0890 | 5.632 | 90.12 | .419 |
| .30 | .0891 | 3.300 | 36.67 | .490 |
| .35 | .0892 | 2.081 | 16.90 | .540 |
| .40 | .0875 | 1.367 | 8.544 | .589 |
| .45 | .0847 | .9297 | 4.591 | .636 |
| .50 | .0807 | .6457 | 2.583 | .674 |
| .55 | .0763 | .4556 | 1.516 | .704 |
| .60 | .0716 | .3315 | .9209 | .723 |
| .65 | .0664 | .2418 | .5722 | .726 |
| .70 | .0612 | .1788 | .3649 | .709 |
| .75 | .0559 | .1325 | .2358 | .682 |

PROPELLER No. 42.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0863 | 10.79 | 269.5 | 0.345 |
| .25 | .0875 | 5.600 | 89.61 | .418 |
| .30 | .0880 | 3.259 | 36.22 | .490 |
| .35 | .0873 | 2.036 | 16.62 | .550 |
| .40 | .0846 | 1.322 | 8.258 | .603 |
| .45 | .0809 | .8880 | 4.335 | .643 |
| .50 | .0767 | .6136 | 2.454 | .685 |
| .55 | .0720 | .4328 | 1.431 | .713 |
| .60 | .0668 | .3093 | .8592 | .725 |
| .65 | .0611 | .2225 | .5266 | .728 |
| .70 | .0553 | .1612 | .3290 | .690 |

TABLE VIII—Continued.

PROPELLER NO. 43.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0770 | 9.625 | 240.6 | 0.371 |
| .25 | .0780 | 4.992 | 79.88 | .448 |
| .30 | .0792 | 2.994 | 32.60 | .510 |
| .35 | .0795 | 1.854 | 15.14 | .565 |
| .40 | .0787 | 1.230 | 7.687 | .614 |
| .45 | .0778 | .8485 | 4.190 | .656 |
| .50 | .0751 | .6009 | 2.404 | .690 |
| .55 | .0723 | .4346 | 1.436 | .717 |
| .60 | .0690 | .3194 | .8874 | .731 |
| .65 | .0653 | .2378 | .5628 | .731 |
| .70 | .0612 | .1785 | .3643 | .711 |
| .75 | .0570 | .1351 | .2402 | .666 |

PROPELLER NO. 44.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0831 | 10.26 | 256.5 | 0.359 |
| .25 | .0833 | 5.331 | 85.30 | .434 |
| .30 | .0838 | 3.108 | 34.48 | .500 |
| .35 | .0828 | 1.931 | 15.77 | .555 |
| .40 | .0807 | 1.261 | 7.882 | .604 |
| .45 | .0776 | .8517 | 4.208 | .647 |
| .50 | .0738 | .5889 | 2.358 | .681 |
| .55 | .0694 | .4171 | 1.379 | .701 |
| .60 | .0647 | .2995 | .8320 | .707 |
| .65 | .0599 | .2181 | .5162 | .696 |
| .70 | .0548 | .1598 | .3261 | .668 |

PROPELLER NO. 45.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0563 | 7.068 | 176.0 | 0.400 |
| .25 | .0564 | 3.610 | 57.76 | .474 |
| .30 | .0561 | 2.078 | 23.09 | .535 |
| .35 | .0551 | 1.285 | 10.49 | .578 |
| .40 | .0535 | .8359 | 5.224 | .602 |
| .45 | .0516 | .5663 | 2.797 | .606 |
| .50 | .0492 | .3936 | 1.574 | .591 |
| .55 | .0465 | .2795 | .9238 | .546 |

PROPELLER NO. 46.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0607 | 7.588 | 189.7 | 0.399 |
| .25 | .0602 | 3.853 | 61.65 | .472 |
| .30 | .0589 | 2.181 | 24.24 | .534 |
| .35 | .0568 | 1.325 | 10.82 | .581 |
| .40 | .0539 | .8430 | 5.263 | .609 |
| .45 | .0501 | .5499 | 2.716 | .615 |
| .50 | .0461 | .3633 | 1.476 | .590 |
| .55 | .0415 | .2494 | .8244 | .530 |

PROPELLER NO. 47.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0518 | 6.476 | 161.9 | 0.415 |
| .25 | .0519 | 3.322 | 53.15 | .489 |
| .30 | .0515 | 1.907 | 21.19 | .545 |
| .35 | .0504 | 1.175 | 9.596 | .585 |
| .40 | .0489 | .7640 | 4.775 | .608 |
| .45 | .0466 | .5115 | 2.526 | .613 |
| .50 | .0442 | .3537 | 1.415 | .602 |
| .55 | .0412 | .2476 | .8184 | .565 |

PROPELLER NO. 48.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0560 | 7.000 | 175.0 | 0.402 |
| .25 | .0557 | 3.565 | 57.04 | .480 |
| .30 | .0544 | 2.015 | 22.39 | .541 |
| .35 | .0522 | 1.217 | 9.935 | .583 |
| .40 | .0496 | .7750 | 4.844 | .605 |
| .45 | .0466 | .5115 | 2.526 | .605 |
| .50 | .0434 | .3472 | 1.390 | .579 |
| .55 | .0400 | .2404 | .7946 | .515 |

PROPELLER NO. 80.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.25 | 0.1101 | 7.049 | 112.8 | 0.355 |
| .30 | .1114 | 4.127 | 45.85 | .414 |
| .35 | .1129 | 2.633 | 21.50 | .470 |
| .40 | .1144 | 1.788 | 11.18 | .520 |
| .45 | .1159 | 1.272 | 6.281 | .567 |
| .50 | .1171 | .9369 | 3.748 | .610 |
| .55 | .1176 | .7068 | 2.337 | .648 |
| .60 | .1170 | .5417 | 1.505 | .680 |
| .65 | .1155 | .4206 | .9954 | .711 |
| .70 | .1130 | .3295 | .6726 | .737 |
| .75 | .1095 | .2596 | .4615 | .760 |
| .80 | .1053 | .2057 | .3214 | .779 |
| .85 | .1000 | .1629 | .2255 | .795 |
| .90 | .0943 | .1294 | .1598 | .806 |
| .95 | .0879 | .1025 | .1136 | .813 |
| 1.00 | .0811 | .0811 | .0811 | .816 |
| 1.05 | .0740 | .0639 | .0580 | .811 |
| 1.10 | .0665 | .0500 | .0412 | .796 |

PROPELLER NO. 81.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.25 | 0.1346 | 8.616 | 137.9 | 0.349 |
| .30 | .1354 | 5.016 | 55.73 | .409 |
| .35 | .1363 | 3.179 | 25.95 | .466 |
| .40 | .1367 | 2.136 | 13.35 | .518 |
| .45 | .1367 | 1.501 | 7.412 | .565 |
| .50 | .1359 | 1.087 | 4.348 | .610 |
| .55 | .1342 | .8066 | 2.667 | .650 |
| .60 | .1315 | .6089 | 1.692 | .684 |
| .65 | .1277 | .4650 | 1.101 | .714 |
| .70 | .1229 | .3584 | .7314 | .740 |
| .75 | .1172 | .2779 | .4941 | .763 |
| .80 | .1107 | .2163 | .3378 | .781 |
| .85 | .1036 | .1690 | .2339 | .795 |
| .90 | .0960 | .1317 | .1626 | .803 |
| .95 | .0880 | .1027 | .1138 | .804 |
| 1.00 | .0797 | .0797 | .0797 | .796 |
| 1.05 | .0711 | .0614 | .0557 | .780 |
| 1.10 | .0624 | .0469 | .0388 | .748 |

PROPELLER NO. 82.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.25 | 0.0993 | 6.356 | 101.7 | 0.374 |
| .30 | .1008 | 3.733 | 41.48 | .436 |
| .35 | .1029 | 2.400 | 19.60 | .490 |
| .40 | .1055 | 1.648 | 10.30 | .540 |
| .45 | .1077 | 1.182 | 5.837 | .584 |
| .50 | .1094 | .8753 | 3.501 | .628 |
| .55 | .1104 | .6636 | 2.194 | .668 |
| .60 | .1106 | .5120 | 1.422 | .704 |
| .65 | .1098 | .3999 | .9465 | .734 |
| .70 | .1080 | .3149 | .6427 | .757 |
| .75 | .1053 | .2496 | .4437 | .778 |
| .80 | .1016 | .1985 | .3103 | .796 |
| .85 | .0974 | .1586 | .2195 | .811 |
| .90 | .0924 | .1267 | .1564 | .823 |
| .95 | .0869 | .1014 | .1124 | .832 |
| 1.00 | .0811 | .0811 | .0811 | .834 |
| 1.05 | .0748 | .0646 | .0588 | .830 |
| 1.10 | .0678 | .0509 | .0421 | .817 |
| 1.15 | .0608 | .0396 | .0300 | .794 |

PROPELLER NO. 83.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.25 | 0.1242 | 7.950 | 127.2 | 0.359 |
| .30 | .1251 | 4.633 | 51.48 | .419 |
| .35 | .1260 | 2.940 | 24.00 | .474 |
| .40 | .1268 | 1.981 | 12.38 | .529 |
| .45 | .1274 | 1.398 | 6.904 | .577 |
| .50 | .1273 | 1.018 | 4.072 | .620 |
| .55 | .1267 | .7616 | 2.518 | .658 |
| .60 | .1255 | .5810 | 1.614 | .693 |
| .65 | .1230 | .4479 | 1.060 | .724 |
| .70 | .1198 | .3493 | .7130 | .750 |
| .75 | .1157 | .2743 | .4877 | .773 |
| .80 | .1107 | .2162 | .3378 | .791 |
| .85 | .1045 | .1702 | .2356 | .806 |
| .90 | .0975 | .1338 | .1652 | .815 |
| .95 | .0898 | .1047 | .1160 | .817 |
| 1.00 | .0814 | .0814 | .0814 | .816 |
| 1.05 | .0725 | .0626 | .0568 | .807 |
| 1.10 | .0629 | .0478 | .0391 | .784 |
| 1.15 | .0530 | .0348 | .0263 | .740 |
| 1.20 | .0427 | .0247 | .0172 | .668 |

TABLE VIII—Continued.

PROPELLER NO. 90.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0500 | 6.260 | 156.2 | 0.426 |
| .25 | .0497 | 3.181 | 50.90 | .504 |
| .30 | .0489 | 1.811 | 20.12 | .570 |
| .35 | .0474 | 1.105 | 9.026 | .621 |
| .40 | .0453 | .7078 | 4.424 | .653 |
| .45 | .0428 | .4693 | 2.330 | .663 |
| .50 | .0398 | .3184 | 1.274 | .665 |
| .55 | .0366 | .2200 | .7272 | .626 |

PROPELLER NO. 91.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0513 | 6.413 | 160.3 | 0.430 |
| .25 | .0502 | 3.213 | 51.41 | .508 |
| .30 | .0486 | 1.800 | 20.00 | .571 |
| .35 | .0464 | 1.082 | 8.832 | .620 |
| .40 | .0434 | .6782 | 4.239 | .651 |
| .45 | .0401 | .4401 | 2.174 | .655 |
| .50 | .0368 | .2920 | 1.168 | .632 |
| .55 | .0326 | .1959 | .6475 | .570 |

PROPELLER NO. 92.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0729 | 9.113 | 227.8 | 0.375 |
| .25 | .0734 | 5.698 | 91.18 | .451 |
| .30 | .0737 | 2.730 | 30.33 | .528 |
| .35 | .0736 | 1.717 | 14.02 | .585 |
| .40 | .0732 | 1.144 | 7.150 | .637 |
| .45 | .0722 | .7924 | 3.914 | .677 |
| .50 | .0705 | .5640 | 2.256 | .710 |
| .55 | .0681 | .4093 | 1.353 | .734 |
| .60 | .0650 | .3009 | .8359 | .749 |
| .65 | .0615 | .2240 | .5302 | .756 |
| .70 | .0574 | .1674 | .3417 | .750 |
| .75 | .0531 | .1259 | .2238 | .728 |
| .80 | .0484 | .0945 | .1477 | .664 |

PROPELLER NO. 93.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0765 | 9.563 | 239.1 | 0.375 |
| .25 | .0760 | 4.865 | 77.84 | .450 |
| .30 | .0750 | 2.778 | 30.86 | .521 |
| .35 | .0737 | 1.719 | 14.02 | .586 |
| .40 | .0719 | 1.1235 | 7.022 | .640 |
| .45 | .0692 | .7596 | 3.751 | .684 |
| .50 | .0656 | .5249 | 2.100 | .715 |
| .55 | .0615 | .3696 | 1.222 | .734 |
| .60 | .0563 | .2630 | .7306 | .739 |
| .65 | .0515 | .1875 | .4437 | .726 |
| .70 | .0459 | .1338 | .2731 | .684 |

PROPELLER NO. 94.

| | | | | |
|---|---|---|---|---|
| 0.25 | 0.0954 | 6.106 | 97.70 | 0.429 |
| .30 | .0968 | 3.585 | 39.84 | .485 |
| .35 | .0980 | 2.286 | 18.67 | .540 |
| .40 | .0987 | 1.542 | 9.638 | .583 |
| .45 | .0990 | 1.067 | 5.269 | .630 |
| .50 | .0987 | .7897 | 3.159 | .667 |
| .55 | .0979 | .5885 | 1.946 | .701 |
| .60 | .0964 | .4463 | 1.240 | .728 |
| .65 | .0940 | .3423 | .8101 | .752 |
| .70 | .0905 | .2639 | .5386 | .771 |
| .75 | .0864 | .2048 | .3641 | .784 |
| .80 | .0816 | .1594 | .2491 | .790 |
| .85 | .0761 | .1239 | .1715 | .790 |
| .90 | .0704 | .0966 | .1193 | .776 |
| .95 | .0642 | .0749 | .0830 | .743 |

PROPELLER NO. 95.

| | | | | |
|---|---|---|---|---|
| 0.25 | 0.1122 | 7.181 | 114.9 | 0.390 |
| .30 | .1127 | 4.174 | 46.37 | .456 |
| .35 | .1127 | 2.628 | 21.46 | .515 |
| .40 | .1120 | 1.750 | 10.94 | .569 |
| .45 | .1106 | 1.214 | 5.996 | .616 |
| .50 | .1088 | .8665 | 3.467 | .659 |
| .55 | .1063 | .6329 | 2.092 | .696 |
| .60 | .1016 | .4704 | 1.307 | .725 |
| .65 | .0970 | .3533 | .8362 | .751 |
| .70 | .0916 | .2671 | .5451 | .767 |
| .75 | .0855 | .2027 | .3604 | .773 |
| .80 | .0789 | .1541 | .2408 | .772 |
| .85 | .0719 | .1171 | .1621 | .768 |
| .90 | .0644 | .0883 | .1090 | .728 |

PROPELLER NO. 96 (ANGLE DECREASED 6°).

| | | | | |
|---|---|---|---|---|
| 0.25 | 0.0489 | 2.810 | 44.96 | 0.471 |
| .30 | .0463 | 1.604 | 17.83 | .532 |
| .35 | .0421 | .9820 | 8.016 | .581 |
| .40 | .0406 | .6328 | 3.955 | .615 |
| .45 | .0387 | .4247 | 2.097 | .632 |
| .50 | .0366 | .2928 | 1.171 | .628 |
| .55 | .0343 | .2062 | .6817 | .596 |
| .60 | .0318 | .1472 | .4090 | .525 |
| .65 | .0292 | .1063 | .2516 | .386 |

PROPELLER NO. 96 (ANGLE DECREASED 4°).

| | | | | |
|---|---|---|---|---|
| 0.25 | 0.0514 | 3.290 | 52.64 | 0.465 |
| .30 | .0506 | 1.881 | 20.90 | .524 |
| .35 | .0494 | 1.152 | 9.405 | .574 |
| .40 | .0474 | .7407 | 4.630 | .619 |
| .45 | .0450 | .4939 | 2.439 | .655 |
| .50 | .0421 | .3368 | 1.347 | .677 |
| .55 | .0390 | .2338 | .7728 | .673 |
| .60 | .0357 | .1653 | .4592 | .630 |
| .65 | .0322 | .1173 | .2776 | .549 |

PROPELLER NO. 96 (STANDARD SETTING).

| | | | | |
|---|---|---|---|---|
| 0.25 | 0.0746 | 4.774 | 76.40 | 0.419 |
| .30 | .0740 | 2.741 | 30.45 | .489 |
| .35 | .0727 | 1.696 | 13.85 | .551 |
| .40 | .0707 | 1.105 | 6.906 | .608 |
| .45 | .0681 | .7474 | 3.691 | .655 |
| .50 | .0651 | .5209 | 2.084 | .694 |
| .55 | .0615 | .3696 | 1.222 | .722 |
| .60 | .0578 | .2676 | .7434 | .740 |
| .65 | .0537 | .1955 | .4630 | .748 |
| .70 | .0495 | .1443 | .2945 | .744 |
| .75 | .0451 | .1069 | .1901 | .716 |

PROPELLER NO. 96 (ANGLE INCREASED 4°).

| | | | | |
|---|---|---|---|---|
| 0.35 | 0.0979 | 2.283 | 18.64 | 0.519 |
| .40 | .0970 | 1.516 | 9.475 | .570 |
| .45 | .0953 | 1.046 | 5.166 | .616 |
| .50 | .0931 | .7449 | 2.980 | .657 |
| .55 | .0899 | .5404 | 1.787 | .691 |
| .60 | .0862 | .3991 | 1.109 | .721 |
| .65 | .0820 | .2986 | .7067 | .746 |
| .70 | .0775 | .2260 | .4612 | .763 |
| .75 | .0728 | .1721 | .3060 | .772 |
| .80 | .0675 | .1318 | .2060 | .771 |
| .85 | .0621 | .1011 | .1399 | .756 |
| .90 | .0565 | .0775 | .0957 | .732 |
| .95 | .0507 | .0591 | .0655 | .669 |

TABLE VIII—Continued.

PROPELLER NO. 96 (ANGLE INCREASED 8°).

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.40 | 0.1183 | 1.848 | 11.55 | 0.518 |
| .45 | .1189 | 1.305 | 6.445 | .565 |
| .50 | .1186 | .9489 | 3.796 | .606 |
| .55 | .1177 | .7074 | 2.339 | .643 |
| .60 | .1159 | .5366 | 1.491 | .677 |
| .65 | .1134 | .4130 | .9776 | .707 |
| .70 | .1104 | .3219 | .6570 | .733 |
| .75 | .1063 | .2520 | .4480 | .752 |
| .80 | .1018 | .1968 | .3107 | .767 |
| .85 | .0965 | .1572 | .2176 | .774 |
| .90 | .0911 | .1250 | .1543 | .775 |
| .95 | .0853 | .0995 | .1108 | .765 |
| 1.00 | .0791 | .0791 | .0791 | .745 |

PROPELLER NO. 96 (ANGLE INCREASED 12°).

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.50 | 0.1444 | 1.155 | 4.620 | 0.534 |
| .55 | .1457 | .8767 | 2.895 | .577 |
| .60 | .1465 | .6782 | 1.884 | .614 |
| .65 | .1464 | .5331 | 1.262 | .648 |
| .70 | .1454 | .4210 | .8654 | .679 |
| .75 | .1436 | .3404 | .6052 | .704 |
| .80 | .1410 | .2754 | .4304 | .725 |
| .85 | .1375 | .2239 | .3099 | .742 |
| .90 | .1331 | .1826 | .2255 | .756 |
| .95 | .1278 | .1491 | .1652 | .765 |
| 1.00 | .1215 | .1215 | .1215 | .770 |
| 1.05 | .1147 | .0991 | .0809 | .771 |
| 1.10 | .1073 | .0806 | .0666 | .767 |
| 1.15 | .0996 | .0655 | .0495 | .755 |
| 1.20 | .0913 | .0528 | .0367 | .733 |
| 1.25 | .0826 | .0423 | .0271 | .702 |

PROPELLER NO. 96 (ANGLE INCREASE 16°).

| | | | | |
|---|---|---|---|---|
| 0.55 | 0.1600 | 0.9617 | 3.179 | 0.533 |
| .60 | .1627 | .7532 | 2.098 | .574 |
| .65 | .1657 | .6034 | 1.428 | .610 |
| .70 | .1682 | .4904 | 1.001 | .644 |
| .75 | .1702 | .4034 | .7179 | .670 |
| .80 | .1713 | .3346 | .5228 | .694 |
| .85 | .1704 | .2775 | .3841 | .713 |
| .90 | .1682 | .2307 | .2848 | .728 |
| .95 | .1646 | .1920 | .2128 | .741 |
| 1.00 | .1596 | .1596 | .1596 | .750 |
| 1.05 | .1539 | .1329 | .1206 | .758 |
| 1.10 | .1478 | .1111 | .0918 | .763 |
| 1.15 | .1412 | .0928 | .0702 | .764 |
| 1.20 | .1344 | .0778 | .0540 | .762 |
| 1.25 | .1271 | .0651 | .0417 | .754 |
| 1.30 | .1198 | .0545 | .0323 | .742 |
| 1.35 | .1121 | .0456 | .0250 | .721 |

PROPELLER NO. 96 (ANGLE INCREASED 20°).

| | | | | |
|---|---|---|---|---|
| 0.65 | 0.1889 | 0.6880 | 1.629 | 0.539 |
| .70 | .1912 | .5575 | 1.138 | .574 |
| .75 | .1942 | .4603 | .8184 | .606 |
| .80 | .1969 | .3846 | .6010 | .635 |
| .85 | .1990 | .3241 | .4486 | .661 |
| .90 | .2003 | .2748 | .3393 | .684 |
| .95 | .2005 | .2339 | .2592 | .704 |
| 1.00 | .1995 | .1995 | .1995 | .720 |
| 1.05 | .1972 | .1704 | .1546 | .732 |
| 1.10 | .1940 | .1458 | .1205 | .742 |
| 1.15 | .1897 | .1247 | .0943 | .748 |
| 1.20 | .1847 | .1069 | .0742 | .753 |
| 1.25 | .1790 | .0917 | .0587 | .756 |
| 1.30 | .1730 | .0787 | .0466 | .756 |
| 1.35 | .1668 | .0678 | .0372 | .753 |
| 1.40 | .1605 | .0585 | .0298 | .745 |
| 1.45 | .1542 | .0506 | .0241 | .734 |
| 1.50 | .1477 | .0438 | .0195 | .719 |

PROPELLER NO. 111.

| | | | | |
|---|---|---|---|---|
| 0.25 | 0.1234 | 7.898 | 126.4 | 0.285 |
| .30 | .1236 | 4.578 | 50.87 | .310 |
| .35 | .1241 | 2.895 | 23.63 | .394 |
| .40 | .1252 | 1.956 | 12.22 | .445 |
| .45 | .1266 | 1.390 | 6.866 | .495 |
| .50 | .1284 | 1.027 | 4.108 | .541 |
| .55 | .1303 | .7831 | 2.589 | .583 |
| .60 | .1318 | .6102 | 1.695 | .623 |
| .65 | .1329 | .4840 | 1.146 | .659 |
| .70 | .1336 | .3896 | .7951 | .689 |
| .75 | .1334 | .3162 | .5622 | .718 |
| .80 | .1322 | .2582 | .4035 | .742 |
| .85 | .1303 | .2122 | .2937 | .764 |
| .90 | .1276 | .1750 | .2161 | .782 |
| .95 | .1237 | .1443 | .1599 | .797 |
| 1.00 | .1189 | .1189 | .1189 | .810 |
| 1.05 | .1133 | .0979 | .0888 | .820 |
| 1.10 | .1070 | .0804 | .0665 | .827 |
| 1.15 | .1000 | .0658 | .0497 | .829 |
| 1.20 | .0927 | .0536 | .0372 | .829 |
| 1.25 | .0850 | .0435 | .0278 | .825 |
| 1.30 | .0766 | .0349 | .0206 | .814 |
| 1.35 | .0686 | .0279 | .0153 | .790 |

PROPELLER NO. 112.

| | | | | |
|---|---|---|---|---|
| 0.25 | 0.1647 | 10.54 | 168.7 | 0.291 |
| .30 | .1659 | 6.145 | 68.28 | .345 |
| .35 | .1671 | 3.898 | 31.82 | .397 |
| .40 | .1685 | 2.633 | 16.46 | .446 |
| .45 | .1698 | 1.864 | 9.206 | .491 |
| .50 | .1703 | 1.362 | 5.448 | .536 |
| .55 | .1702 | 1.023 | 3.382 | .577 |
| .60 | .1691 | .7830 | 2.175 | .617 |
| .65 | .1672 | .6089 | 1.441 | .651 |
| .70 | .1646 | .4799 | .9795 | .682 |
| .75 | .1611 | .3819 | .6790 | .710 |
| .80 | .1570 | .3067 | .4793 | .735 |
| .85 | .1520 | .2475 | .3426 | .756 |
| .90 | .1462 | .2005 | .2475 | .775 |
| .95 | .1395 | .1627 | .1803 | .790 |
| 1.00 | .1319 | .1319 | .1319 | .802 |
| 1.05 | .1234 | .1066 | .0967 | .810 |
| 1.10 | .1141 | .0857 | .0709 | .815 |
| 1.15 | .1049 | .0690 | .0522 | .816 |
| 1.20 | .0951 | .0550 | .0382 | .813 |
| 1.25 | .0853 | .0437 | .0280 | .801 |
| 1.30 | .0753 | .0343 | .0203 | .777 |

PROPELLER NO. 113.

| | | | | |
|---|---|---|---|---|
| 0.25 | 0.1209 | 7.738 | 123.8 | 0.311 |
| .30 | .1221 | 4.523 | 50.25 | .369 |
| .35 | .1237 | 2.885 | 23.55 | .425 |
| .40 | .1260 | 1.969 | 12.31 | .478 |
| .45 | .1289 | 1.415 | 6.987 | .529 |
| .50 | .1320 | 1.056 | 4.224 | .577 |
| .55 | .1354 | .8138 | 2.690 | .619 |
| .60 | .1380 | .6390 | 1.775 | .655 |
| .65 | .1395 | .5080 | 1.202 | .685 |
| .70 | .1400 | .4082 | .8331 | .711 |
| .75 | .1394 | .3304 | .5874 | .735 |
| .80 | .1380 | .2696 | .4213 | .756 |
| .85 | .1357 | .2210 | .3059 | .775 |
| .90 | .1327 | .1820 | .2247 | .791 |
| .95 | .1288 | .1502 | .1664 | .806 |
| 1.00 | .1240 | .1240 | .1240 | .819 |
| 1.05 | .1185 | .1024 | .0929 | .831 |
| 1.10 | .1124 | .0844 | .0698 | .835 |
| 1.15 | .1059 | .0696 | .0526 | .840 |
| 1.20 | .0990 | .0573 | .0398 | .837 |
| 1.25 | .0915 | .0469 | .0300 | .826 |
| 1.30 | .0837 | .0381 | .0225 | .808 |

PROPELLER NO. 114.

| | | | | |
|---|---|---|---|---|
| 0.25 | 0.1453 | 9.332 | 149.3 | 0.311 |
| .30 | .1476 | 5.467 | 60.75 | .369 |
| .35 | .1497 | 3.492 | 28.51 | .422 |
| .40 | .1519 | 2.373 | 14.83 | .473 |
| .45 | .1538 | 1.688 | 8.336 | .518 |
| .50 | .1557 | 1.246 | 4.984 | .561 |
| .55 | .1574 | .9461 | 3.128 | .599 |
| .60 | .1588 | .7352 | 2.042 | .634 |
| .65 | .1595 | .5808 | 1.375 | .665 |
| .70 | .1596 | .4659 | .9406 | .694 |
| .75 | .1582 | .3750 | .6666 | .719 |
| .80 | .1556 | .3040 | .4750 | .742 |
| .85 | .1514 | .2468 | .3413 | .761 |
| .90 | .1458 | .2000 | .2470 | .780 |
| .95 | .1386 | .1617 | .1792 | .795 |
| 1.00 | .1308 | .1308 | .1308 | .807 |
| 1.05 | .1224 | .1067 | .0959 | .817 |
| 1.10 | .1137 | .0884 | .0706 | .823 |
| 1.15 | .1049 | .0692 | .0522 | .826 |
| 1.20 | .0957 | .0554 | .0385 | .822 |
| 1.25 | .0865 | .0443 | .0284 | .811 |
| 1.30 | .0770 | .0350 | .0207 | .790 |

TABLE VIII—Continued.

PROPELLER NO. 115.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0404 | 5.050 | 126.2 | 0.422 |
| .25 | .0400 | 2.580 | 40.96 | .508 |
| .30 | .0394 | 1.459 | 16.22 | .579 |
| .35 | .0380 | .8863 | 7.236 | .632 |
| .40 | .0358 | .5594 | 3.496 | .674 |
| .45 | .0334 | .3666 | 1.811 | .700 |
| .50 | .0304 | .2432 | .9728 | .705 |
| .55 | .0271 | .1629 | .5384 | .681 |
| .60 | .0236 | .1092 | .3035 | .624 |

PROPELLER NO. 116.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0556 | 6.950 | 173.8 | 0.384 |
| .25 | .0552 | 3.533 | 56.53 | .459 |
| .30 | .0547 | 2.026 | 22.51 | .521 |
| .35 | .0538 | 1.255 | 10.25 | .580 |
| .40 | .0527 | .8235 | 5.147 | .632 |
| .45 | .0513 | .5631 | 2.781 | .680 |
| .50 | .0496 | .3968 | 1.587 | .718 |
| .55 | .0473 | .2843 | .9398 | .751 |
| .60 | .0441 | .2042 | .5673 | .769 |
| .65 | .0404 | .1471 | .3481 | .775 |
| .70 | .0364 | .1061 | .2165 | .760 |
| .75 | .0320 | .0758 | .1348 | .720 |

PROPELLER NO. 117.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0746 | 9.325 | 233.1 | 0.360 |
| .25 | .0752 | 4.813 | 77.02 | .431 |
| .30 | .0760 | 2.815 | 31.28 | .492 |
| .35 | .0766 | 1.787 | 14.59 | .547 |
| .40 | .0771 | 1.205 | 7.531 | .594 |
| .45 | .0776 | .8518 | 4.207 | .636 |
| .50 | .0777 | .6217 | 2.487 | .673 |
| .55 | .0771 | .4634 | 1.532 | .706 |
| .60 | .0757 | .3505 | .9736 | .737 |
| .65 | .0727 | .2648 | .6267 | .764 |
| .70 | .0688 | .2006 | .4094 | .782 |
| .75 | .0639 | .1515 | .2693 | .795 |
| .80 | .0578 | .1129 | .1764 | .798 |
| .85 | .0512 | .0834 | .1154 | .790 |
| .90 | .0443 | .0608 | .0751 | .770 |
| .95 | .0370 | .0432 | .0479 | .724 |

PROPELLER No. 118.

| | | | | |
|---|---|---|---|---|
| 0.25 | 0.0937 | 5.997 | 95.96 | 0.357 |
| .30 | .0945 | 3.500 | 38.89 | .421 |
| .35 | .0959 | 2.237 | 18.26 | .483 |
| .40 | .0972 | 1.519 | 9.493 | .540 |
| .45 | .0984 | 1.080 | 5.333 | .590 |
| .50 | .0999 | .7993 | 3.197 | .631 |
| .55 | .1009 | .6065 | 2.005 | .668 |
| .60 | .1011 | .4681 | 1.300 | .699 |
| .65 | .1010 | .3678 | .8706 | .727 |
| .70 | .1000 | .2915 | .5962 | .753 |
| .75 | .0980 | .2328 | .4130 | .773 |
| .80 | .0946 | .1848 | .2887 | .789 |
| .85 | .0902 | .1469 | .2033 | .801 |
| .90 | .0852 | .1169 | .1443 | .810 |
| .95 | .0792 | .0924 | .1024 | .818 |
| 1.00 | .0729 | .0729 | .0729 | .819 |
| 1.05 | .0660 | .0570 | .0517 | .817 |
| 1.10 | .0586 | .0440 | .0364 | .804 |
| 1.15 | .0509 | .0335 | .0253 | .774 |

PROPELLER No. 119.

| | | | | |
|---|---|---|---|---|
| 0.25 | 0.1128 | 7.220 | 115.5 | 0.301 |
| .30 | .1130 | 4.185 | 46.50 | .359 |
| .35 | .1131 | 2.633 | 21.54 | .411 |
| .40 | .1137 | 1.777 | 11.11 | .464 |
| .45 | .1144 | 1.255 | 6.198 | .512 |
| .50 | .1153 | .9223 | 3.690 | .561 |
| .55 | .1164 | .6993 | 2.313 | .606 |
| .60 | .1177 | .5449 | 1.514 | .646 |
| .65 | .1195 | .4351 | 1.030 | .680 |
| .70 | .1210 | .3528 | .7200 | .710 |
| .75 | .1220 | .2892 | .5141 | .738 |
| .80 | .1221 | .2385 | .3727 | .760 |
| .85 | .1250 | .2036 | .2818 | .779 |
| .90 | .1196 | .1641 | .2026 | .790 |
| .95 | .1167 | .1361 | .1508 | .806 |
| 1.00 | .1126 | .1126 | .1126 | .812 |
| 1.05 | .1073 | .0927 | .0841 | .817 |
| 1.10 | .1011 | .0760 | .0628 | .818 |
| 1.15 | .0935 | .0615 | .0465 | .812 |
| 1.20 | .0851 | .0492 | .0342 | .802 |
| 1.25 | .0762 | .0390 | .0250 | .785 |
| 1.30 | .0670 | .0305 | .0181 | .758 |

PROPELLER No. 120.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0625 | 7.814 | 195.4 | 0.362 |
| .25 | .0617 | 3.949 | 63.19 | .440 |
| .30 | .0605 | 2.241 | 24.90 | .506 |
| .35 | .0592 | 1.381 | 11.27 | .570 |
| .40 | .0576 | .9000 | 5.625 | .628 |
| .45 | .0554 | .6081 | 3.003 | .667 |
| .50 | .0525 | .4200 | 1.680 | .701 |
| .55 | .0489 | .2939 | .9714 | .728 |
| .60 | .0447 | .2069 | .5749 | .731 |
| .65 | .0400 | .1457 | .3443 | .716 |
| .70 | .0351 | .1023 | .2088 | .677 |

PROPELLER No. 121.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0620 | 7.750 | 193.8 | 0.371 |
| .25 | .0617 | 3.949 | 63.19 | .443 |
| .30 | .0612 | 2.267 | 25.19 | .518 |
| .35 | .0603 | 1.406 | 11.48 | .572 |
| .40 | .0592 | .9250 | 5.782 | .619 |
| .45 | .0575 | .6311 | 3.117 | .661 |
| .50 | .0553 | .4424 | 1.770 | .695 |
| .55 | .0521 | .3131 | 1.035 | .720 |
| .60 | .0487 | .2255 | .6265 | .737 |
| .65 | .0448 | .1631 | .3860 | .739 |
| .70 | .0407 | .1187 | .2123 | .714 |
| .75 | .0364 | .0863 | .1534 | .641 |

PROPELLER No. 122.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0659 | 8.238 | 206.0 | 0.367 |
| .25 | .0655 | 4.199 | 67.20 | .440 |
| .30 | .0651 | 2.411 | 26.79 | .504 |
| .35 | .0645 | 1.504 | 12.28 | .555 |
| .40 | .0635 | .9922 | 6.201 | .608 |
| .45 | .0623 | .6833 | 3.377 | .649 |
| .50 | .0604 | .4833 | 1.933 | .687 |
| .55 | .0582 | .3498 | 1.158 | .721 |
| .60 | .0556 | .2575 | .7153 | .745 |
| .65 | .0526 | .1915 | .4533 | .759 |
| .70 | .0492 | .1435 | .2929 | .765 |
| .75 | .0453 | .1074 | .1909 | .728 |

TABLE VIII—Continued.

PROPELLER NO. 126.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0625 | 7.814 | 195.4 | 0.357 |
| .25 | .0627 | 4.018 | 64.22 | .431 |
| .30 | .0628 | 2.326 | 25.84 | .499 |
| .35 | .0628 | 1.465 | 11.96 | .554 |
| .40 | .0625 | .9766 | 6.104 | .606 |
| .45 | .0622 | .6637 | 3.372 | .662 |
| .50 | .0615 | .4921 | 1.968 | .693 |
| .55 | .0604 | .3630 | 1.200 | .725 |
| .60 | .0585 | .2708 | .7524 | .744 |
| .65 | .0554 | .2017 | .4774 | .756 |
| .70 | .0514 | .1498 | .3057 | .755 |
| .75 | .0469 | .1112 | .1977 | .736 |
| .80 | .0417 | .0815 | .1273 | .696 |

PROPELLER NO. 127.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.20 | 0.0401 | 5.013 | 125.3 | 0.430 |
| .25 | .0395 | 2.528 | 40.45 | .491 |
| .30 | .0385 | 1.426 | 15.84 | .543 |
| .35 | .0368 | .8584 | 7.008 | .592 |
| .40 | .0346 | .5406 | 3.379 | .627 |
| .45 | .0320 | .3512 | 1.735 | .644 |
| .50 | .0291 | .2328 | .9312 | .624 |
| .55 | .0261 | .1569 | .5186 | .580 |

PROPELLER NO. 128.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0369 | 4.618 | 115.3 | 0.440 |
| .25 | .0358 | 2.291 | 36.66 | .508 |
| .30 | .0346 | 1.281 | 14.24 | .562 |
| .35 | .0329 | .7674 | 6.265 | .598 |
| .40 | .0308 | .4812 | 3.007 | .615 |
| .45 | .0287 | .3150 | 1.556 | .606 |
| .50 | .0264 | .2112 | .8448 | .563 |

PROPELLER NO. 129.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0632 | 7.900 | 197.5 | 0.403 |
| .25 | .0630 | 4.032 | 64.52 | .473 |
| .30 | .0629 | 2.330 | 25.90 | .533 |
| .35 | .0621 | 1.448 | 11.83 | .586 |
| .40 | .0611 | .9548 | 5.968 | .632 |
| .45 | .0595 | .6530 | 3.225 | .671 |
| .50 | .0573 | .4585 | 1.834 | .706 |
| .55 | .0545 | .3276 | 1.083 | .731 |
| .60 | .0511 | .2366 | .6573 | .746 |
| .65 | .0473 | .1722 | .4075 | .747 |
| .70 | .0429 | .1251 | .2553 | .733 |
| .75 | .0379 | .0898 | .1597 | .690 |

PROPELLER NO. 130.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0600 | 7.500 | 187.5 | 0.402 |
| .25 | .0596 | 3.815 | 61.04 | .474 |
| .30 | .0590 | 2.185 | 24.28 | .532 |
| .35 | .0582 | 1.358 | 11.09 | .583 |
| .40 | .0573 | .8953 | 5.596 | .629 |
| .45 | .0559 | .6135 | 3.030 | .667 |
| .50 | .0539 | .4312 | 1.725 | .696 |
| .55 | .0515 | .3095 | 1.023 | .718 |
| .60 | .0481 | .2227 | .6186 | .724 |
| .65 | .0441 | .1606 | .3801 | .710 |
| .70 | .0392 | .1143 | .2333 | .669 |

PROPELLER NO. 131.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0828 | 10.35 | 258.8 | 0.355 |
| .25 | .0840 | 5.377 | 86.04 | .421 |
| .30 | .0855 | 3.166 | 35.18 | .490 |
| .35 | .0873 | 2.036 | 16.62 | .532 |
| .40 | .0880 | 1.375 | 8.595 | .581 |
| .45 | .0878 | .9637 | 4.760 | .626 |
| .50 | .0866 | .6929 | 2.772 | .668 |
| .55 | .0845 | .5079 | 1.679 | .705 |
| .60 | .0817 | .3782 | 1.050 | .740 |
| .65 | .0783 | .2851 | .6748 | .768 |
| .70 | .0741 | .2161 | .4410 | .789 |
| .75 | .0692 | .1640 | .2915 | .798 |
| .80 | .0639 | .1248 | .1950 | .800 |
| .85 | .0582 | .0948 | .1312 | .791 |
| .90 | .0523 | .0717 | .0885 | .772 |
| .95 | .0462 | .0539 | .0597 | .730 |

PROPELLER NO. 132.

| | | | | |
|---|---|---|---|---|
| 0.20 | 0.0822 | 10.27 | 256.9 | 0.364 |
| .25 | .0838 | 5.364 | 85.85 | .431 |
| .30 | .0859 | 3.181 | 35.34 | .493 |
| .35 | .0874 | 2.039 | 16.65 | .547 |
| .40 | .0881 | 1.376 | 8.600 | .595 |
| .45 | .0881 | .9670 | 4.776 | .637 |
| .50 | .0870 | .6961 | 2.784 | .672 |
| .55 | .0848 | .5097 | 1.685 | .705 |
| .60 | .0818 | .3787 | 1.052 | .734 |
| .65 | .0780 | .2841 | .6723 | .759 |
| .70 | .0737 | .2149 | .4386 | .776 |
| .75 | .0687 | .1628 | .2894 | .786 |
| .80 | .0633 | .1237 | .1933 | .788 |
| .85 | .0575 | .0936 | .1296 | .780 |
| .90 | .0518 | .0704 | .0869 | .756 |
| .95 | .0449 | .0524 | .0581 | .706 |

PROPELLER NO. 133.

| | | | | |
|---|---|---|---|---|
| 0.25 | 0.1038 | 6.642 | 106.3 | 0.349 |
| .30 | .1047 | 3.877 | 43.08 | .410 |
| .35 | .1060 | 2.472 | 20.18 | .467 |
| .40 | .1075 | 1.680 | 10.50 | .521 |
| .45 | .1093 | 1.200 | 5.926 | .573 |
| .50 | .1107 | .8856 | 3.543 | .619 |
| .55 | .1117 | .6713 | 2.219 | .660 |
| .60 | .1119 | .5181 | 1.439 | .695 |
| .65 | .1110 | .4043 | .9570 | .724 |
| .70 | .1093 | .3187 | .6505 | .750 |
| .75 | .1067 | .2529 | .4496 | .773 |
| .80 | .1037 | .2026 | .3166 | .789 |
| .85 | .1000 | .1628 | .2253 | .804 |
| .90 | .0955 | .1310 | .1617 | .810 |
| .95 | .0902 | .1052 | .1166 | .810 |
| 1.00 | .0841 | .0841 | .0841 | .808 |
| 1.05 | .0774 | .0669 | .0607 | .801 |
| 1.10 | .0702 | .0527 | .0436 | .782 |
| 1.15 | .0626 | .0412 | .0311 | .747 |

TABLE VIII—Continued.

PROPELLER NO. 134.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.25 | 0.1030 | 6.592 | 105.5 | 0.370 |
| .30 | .1043 | 3.363 | 42.92 | .432 |
| .35 | .1062 | 2.477 | 20.22 | .488 |
| .40 | .1085 | 1.695 | 10.60 | .539 |
| .45 | .1105 | 1.218 | 5.990 | .583 |
| .50 | .1121 | .8969 | 3.583 | .625 |
| .55 | .1130 | .6792 | 2.245 | .661 |
| .60 | .1132 | .5241 | 1.456 | .695 |
| .65 | .1127 | .4104 | .9712 | .721 |
| .70 | .1114 | .3248 | .6629 | .746 |
| .75 | .1091 | .2586 | .4597 | .767 |
| .80 | .1060 | .2070 | .3235 | .784 |
| .85 | .1021 | .1663 | .2302 | .797 |
| .90 | .0974 | .1336 | .1680 | .805 |
| .95 | .0921 | .1074 | .1190 | .810 |
| 1.00 | .0865 | .0865 | .0865 | .810 |
| 1.05 | .0806 | .0696 | .0632 | .806 |
| 1.10 | .0745 | .0560 | .0463 | .796 |
| 1.15 | .0681 | .0443 | .0339 | .772 |

PROPELLER NO. 135.

| $\frac{V}{ND}$ | $C_1$ | $C_2$ | $C_3$ | Efficiency. |
|---|---|---|---|---|
| 0.25 | 0.1019 | 6.821 | 104.3 | 0.380 |
| .30 | .1082 | 3.828 | 42.48 | .439 |
| .35 | .1060 | 2.450 | 20.00 | .493 |
| .40 | .1074 | 1.678 | 10.49 | .543 |
| .45 | .1101 | 1.208 | 5.966 | .587 |
| .50 | .1122 | .8977 | 3.591 | .624 |
| .55 | .1130 | .6792 | 2.245 | .660 |
| .60 | .1129 | .5227 | 1.452 | .691 |
| .65 | .1118 | .4072 | .9633 | .720 |
| .70 | .1098 | .3202 | .6535 | .744 |
| .75 | .1070 | .2536 | .4509 | .767 |
| .80 | .1031 | .2014 | .3147 | .784 |
| .85 | .0987 | .1607 | .2224 | .799 |
| .90 | .0936 | .1284 | .1585 | .810 |
| .95 | .0877 | .1023 | .1134 | .815 |
| 1.00 | .0811 | .0811 | .0811 | .815 |
| 1.05 | .0742 | .0641 | .0581 | .807 |
| 1.10 | .0669 | .0503 | .0416 | .785 |
| 1.15 | .0590 | .0388 | .0293 | .741 |

PROPELLER NO. 136.

| | | | | |
|---|---|---|---|---|
| 0.25 | 0.1266 | 8.108 | 129.7 | 0.289 |
| .30 | .1263 | 4.697 | 52.18 | .345 |
| .35 | .1272 | 2.967 | 24.22 | .400 |
| .40 | .1278 | 1.997 | 12.48 | .454 |
| .45 | .1287 | 1.413 | 6.978 | .506 |
| .50 | .1299 | 1.039 | 4.156 | .553 |
| .55 | .1316 | .7910 | 2.615 | .597 |
| .60 | .1341 | .6209 | 1.725 | .640 |
| .65 | .1367 | .4978 | 1.178 | .677 |
| .70 | .1394 | .4065 | .8296 | .710 |
| .75 | .1412 | .3348 | .5952 | .737 |
| .80 | .1416 | .2766 | .4322 | .759 |
| .85 | .1403 | .2285 | .3163 | .778 |
| .90 | .1380 | .1893 | .2337 | .794 |
| .95 | .1346 | .1570 | .1740 | .805 |
| 1.00 | .1303 | .1303 | .1303 | .815 |
| 1.05 | .1250 | .1080 | .0980 | .820 |
| 1.10 | .1191 | .0895 | .0740 | .824 |
| 1.15 | .1128 | .0738 | .0558 | .825 |
| 1.20 | .1046 | .0605 | .0420 | .821 |
| 1.25 | .0966 | .0495 | .0317 | .810 |
| 1.30 | .0881 | .0401 | .0237 | .790 |
| 1.35 | .0797 | .0324 | .0178 | .762 |

PROPELLER NO. 137.

| | | | | |
|---|---|---|---|---|
| 0.25 | 0.1210 | 7.744 | 123.9 | 0.301 |
| .30 | .1214 | 4.497 | 49.97 | .360 |
| .35 | .1221 | 2.843 | 23.25 | .417 |
| .40 | .1234 | 1.928 | 12.05 | .474 |
| .45 | .1251 | 1.373 | 6.780 | .527 |
| .50 | .1274 | 1.019 | 4.076 | .575 |
| .55 | .1302 | .7826 | 2.587 | .616 |
| .60 | .1334 | .6176 | 1.715 | .654 |
| .65 | .1360 | .4962 | 1.172 | .687 |
| .70 | .1378 | .4018 | .8200 | .715 |
| .75 | .1390 | .3295 | .5858 | .739 |
| .80 | .1390 | .2715 | .4242 | .760 |
| .85 | .1380 | .2247 | .3110 | .780 |
| .90 | .1360 | .1865 | .2303 | .795 |
| .95 | .1327 | .1548 | .1715 | .807 |
| 1.00 | .1284 | .1284 | .1284 | .815 |
| 1.05 | .1230 | .1063 | .0964 | .822 |
| 1.10 | .1168 | .0877 | .0725 | .824 |
| 1.15 | .1100 | .0723 | .0547 | .821 |
| 1.20 | .1029 | .0595 | .0413 | .814 |
| 1.25 | .0950 | .0486 | .0311 | .801 |
| 1.30 | .0870 | .0396 | .0234 | .785 |
| 1.35 | .0785 | .0319 | .0175 | .762 |

PROPELLER NO. 138.

| | | | | |
|---|---|---|---|---|
| 0.25 | 0.1266 | 8.103 | 129.6 | 0.317 |
| .30 | .1280 | 4.740 | 52.67 | .372 |
| .35 | .1296 | 3.023 | 24.63 | .426 |
| .40 | .1330 | 2.063 | 12.90 | .478 |
| .45 | .1345 | 1.476 | 7.290 | .525 |
| .50 | .1375 | 1.100 | 4.400 | .569 |
| .55 | .1407 | .8457 | 2.796 | .607 |
| .60 | .1430 | .6630 | 1.839 | .645 |
| .65 | .1447 | .5269 | 1.247 | .679 |
| .70 | .1453 | .4237 | .8648 | .707 |
| .75 | .1448 | .3438 | .6108 | .733 |
| .80 | .1431 | .2795 | .4367 | .757 |
| .85 | .1407 | .2291 | .3171 | .775 |
| .90 | .1373 | .1883 | .2325 | .791 |
| .95 | .1330 | .1561 | .1718 | .808 |
| 1.00 | .1282 | .1282 | .1282 | .813 |
| 1.05 | .1229 | .1062 | .0968 | .821 |
| 1.10 | .1170 | .0879 | .0737 | .826 |
| 1.15 | .1105 | .0727 | .0550 | .827 |
| 1.20 | .1037 | .0600 | .0417 | .824 |
| 1.25 | .0961 | .0492 | .0315 | .817 |
| 1.30 | .0881 | .0402 | .0238 | .804 |
| 1.35 | .0800 | .0326 | .0178 | .784 |

PROPELLER NO. 139.

| | | | | |
|---|---|---|---|---|
| 0.15 | 0.0249 | 7.38 | 328.0 | 0.335 |
| .20 | .0247 | 3.088 | 77.20 | .469 |
| .25 | .0241 | 1.542 | 24.68 | .517 |
| .30 | .0234 | .8657 | 9.630 | .522 |
| .35 | .0225 | .5243 | 4.285 | .490 |
| .40 | .0214 | .3342 | 2.090 | .415 |

PROPELLER NO. 144.

| | | | | |
|---|---|---|---|---|
| 0.15 | 0.0234 | 6.932 | 308.0 | 0.305 |
| .20 | .0226 | 2.835 | 70.62 | .451 |
| .25 | .0216 | 1.383 | 22.12 | .488 |
| .30 | .0201 | .7446 | 8.271 | .470 |
| .35 | .0183 | .4269 | 3.436 | .399 |
| .40 | .0161 | .2515 | 1.578 | .344 |

PROPELLER NO. 145.

| | | | | |
|---|---|---|---|---|
| 0.15 | 0.0262 | 7.763 | 345.0 | 0.37 |
| .20 | .0261 | 3.263 | 81.58 | .448 |
| .25 | .0258 | 1.651 | 26.42 | .491 |
| .30 | .0253 | .9373 | 10.41 | .501 |
| .35 | .0243 | .5663 | 4.667 | .47 |
| .40 | .0231 | .3610 | 2.256 | .40 |
| .45 | .0218 | .2392 | 1.182 | .276 |

PROPELLER NO. 146.

| | | | | |
|---|---|---|---|---|
| 0.15 | 0.0258 | 7.645 | 330.8 | 0.352 |
| .20 | .0245 | 3.063 | 75.58 | .451 |
| .25 | .0230 | 1.473 | 23.55 | .493 |
| .30 | .0211 | .7818 | 8.695 | .491 |
| .35 | .0193 | .4502 | 3.675 | .432 |
| .40 | .0170 | .2656 | 1.660 | .284 |

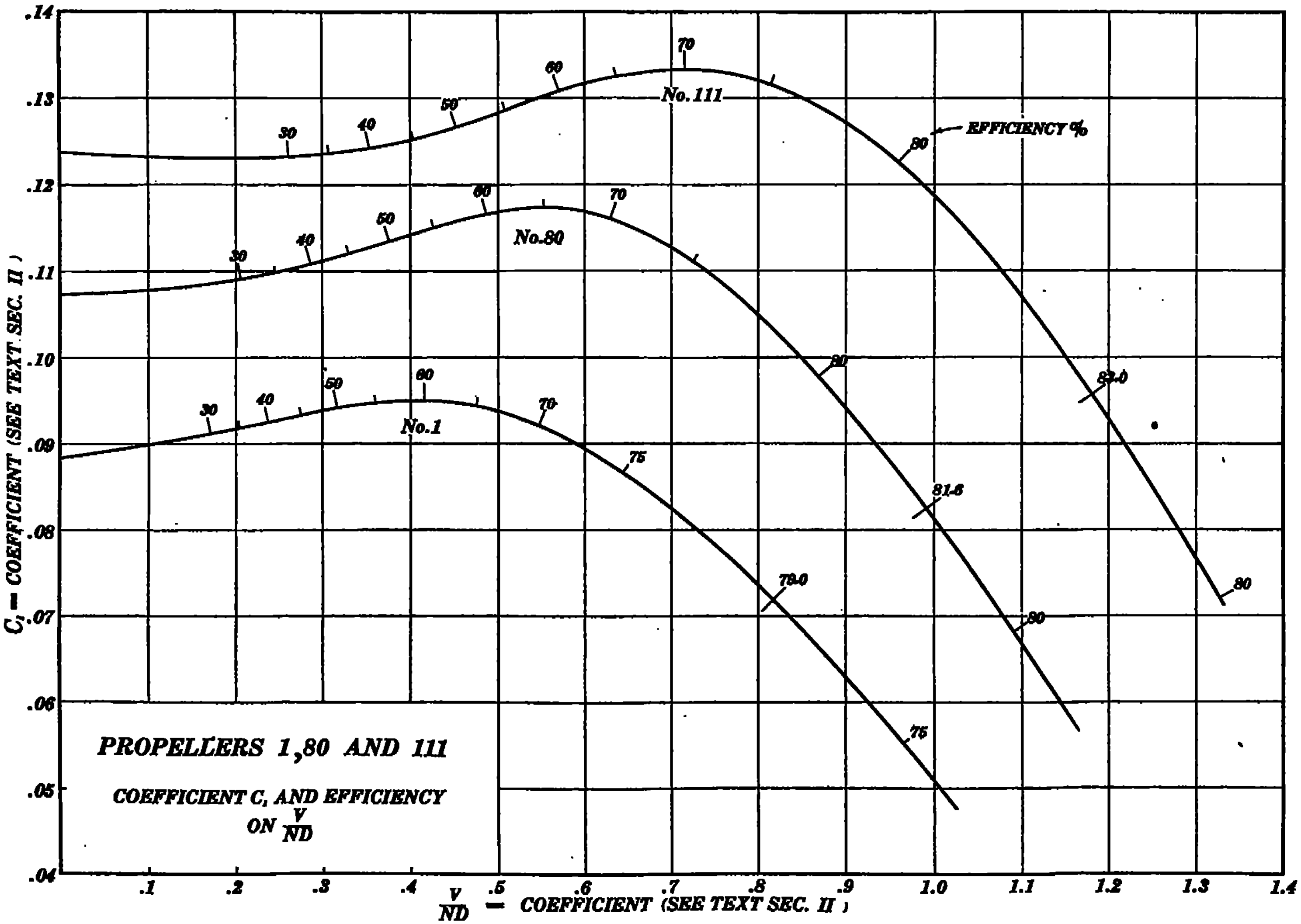

PROPELLERS 1,80 AND 111
COEFFICIENT $C_1$ AND EFFICIENCY ON $\frac{V}{ND}$
$C_1$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)
EFFICIENCY %
No.111
No.80
No.1
.14
.13
.12
.11
.10
.09
.08
.07
.06
.05
.04
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4
83.0
81.8
79.0
75
80

FIG. 19.

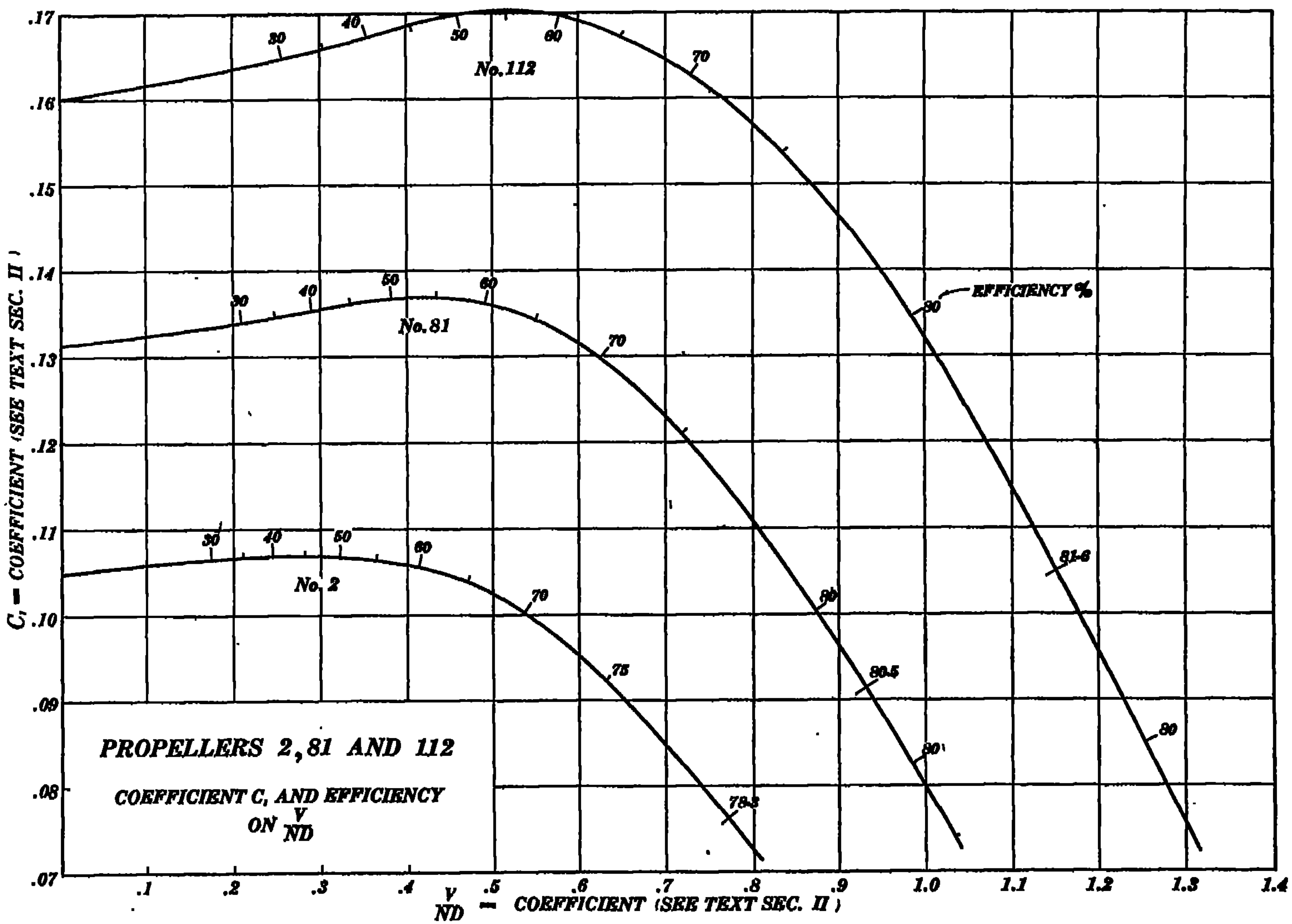

PROPELLERS 2, 81 AND 112
COEFFICIENT $C_s$ AND EFFICIENCY ON $\frac{V}{ND}$
$C_s$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)
No. 112
No. 81
No. 2
EFFICIENCY %
.17
.16
.15
.14
.13
.12
.11
.10
.09
.08
.07
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4

FIG. 20.

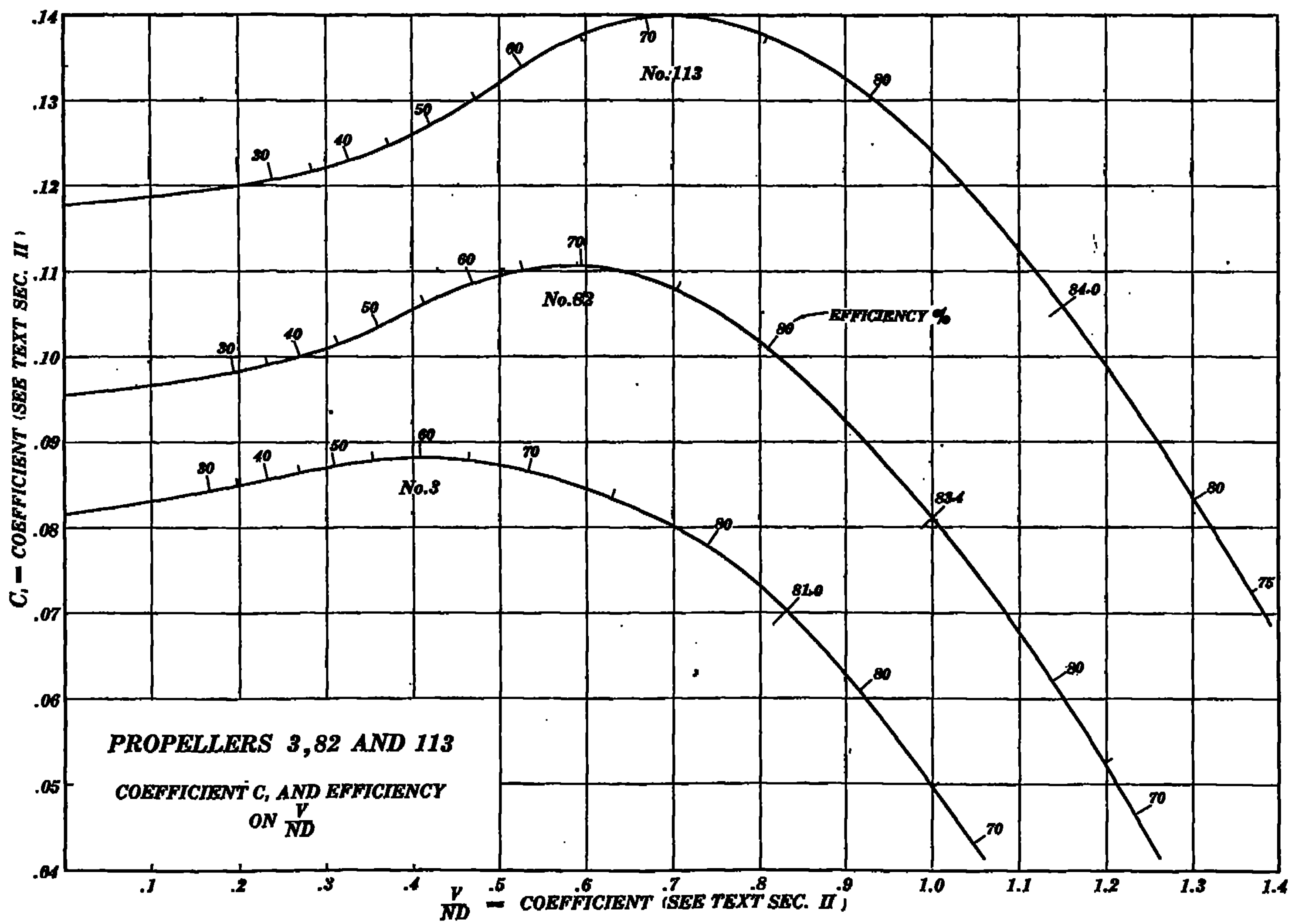

PROPELLERS 3,82 AND 113
COEFFICIENT $C_t$ AND EFFICIENCY ON $\frac{V}{ND}$
No. 113
No. 82
No. 3
EFFICIENCY %
$C_t$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)
84.0
83.4
81.0

FIG. 21.

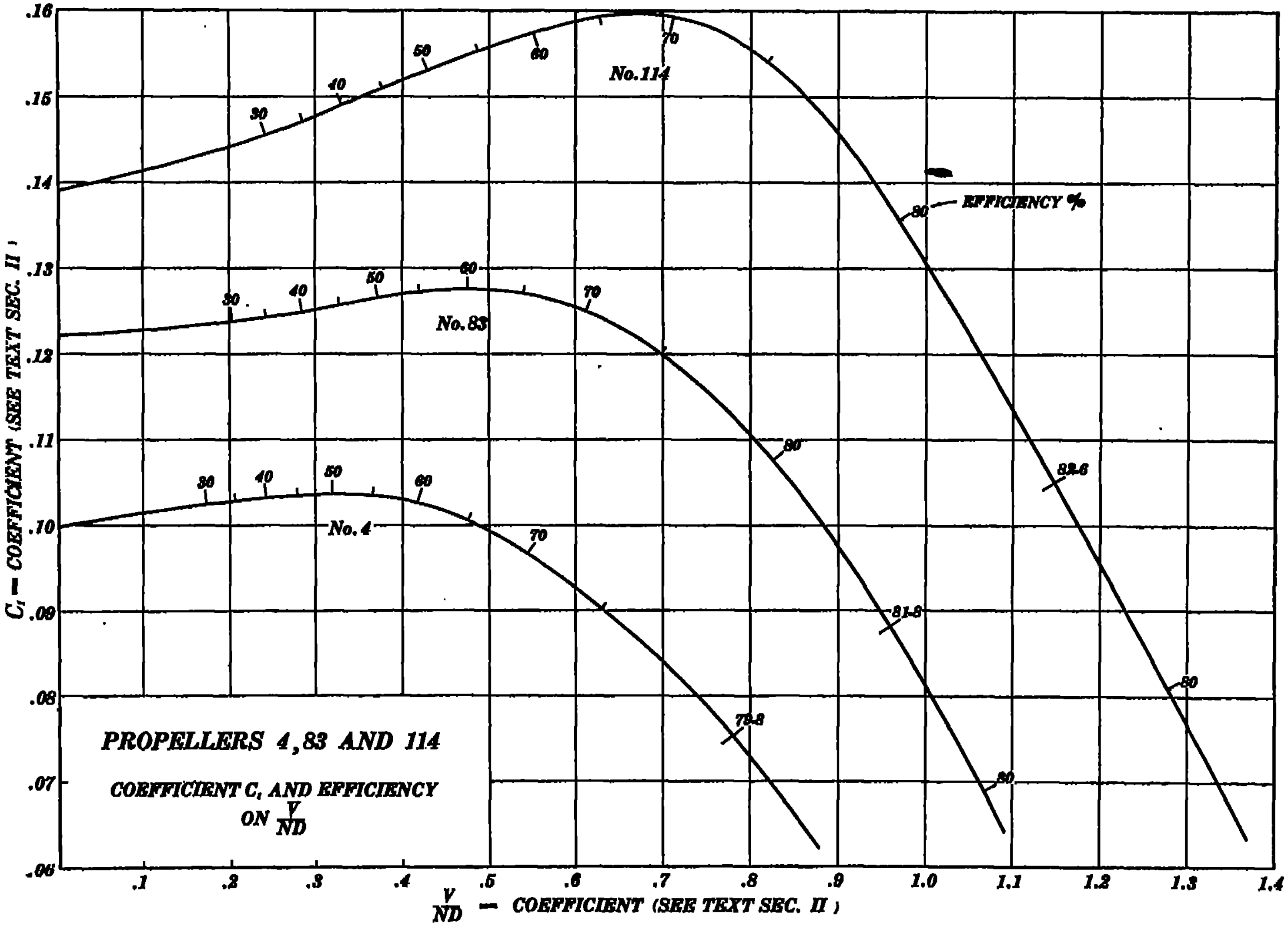

PROPELLERS 4, 83 AND 114
COEFFICIENT $C_t$ AND EFFICIENCY ON $\frac{V}{ND}$
$C_t$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)
No. 114
No. 83
No. 4
EFFICIENCY %
.16
.15
.14
.13
.12
.11
.10
.09
.08
.07
.06
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4
30
40
50
60
70
80
82.6
81.8
79.8

Fig. 22.

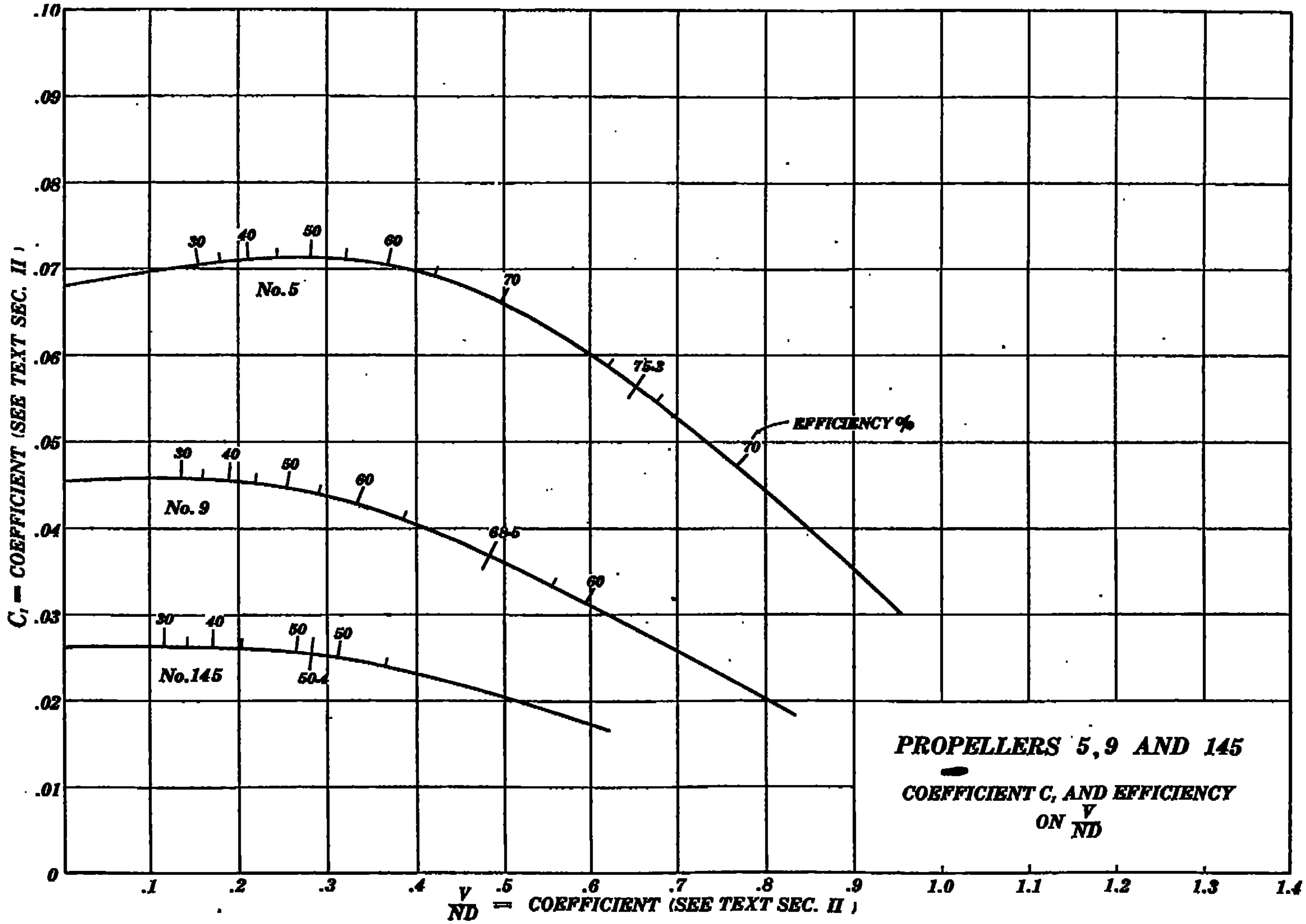

PROPELLERS 5, 9 AND 145
COEFFICIENT $C_1$ AND EFFICIENCY ON $\frac{V}{ND}$
$C_1$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)
No. 5
No. 9
No. 145
EFFICIENCY %
75.3
68.5
50.4
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4

Fig. 23.

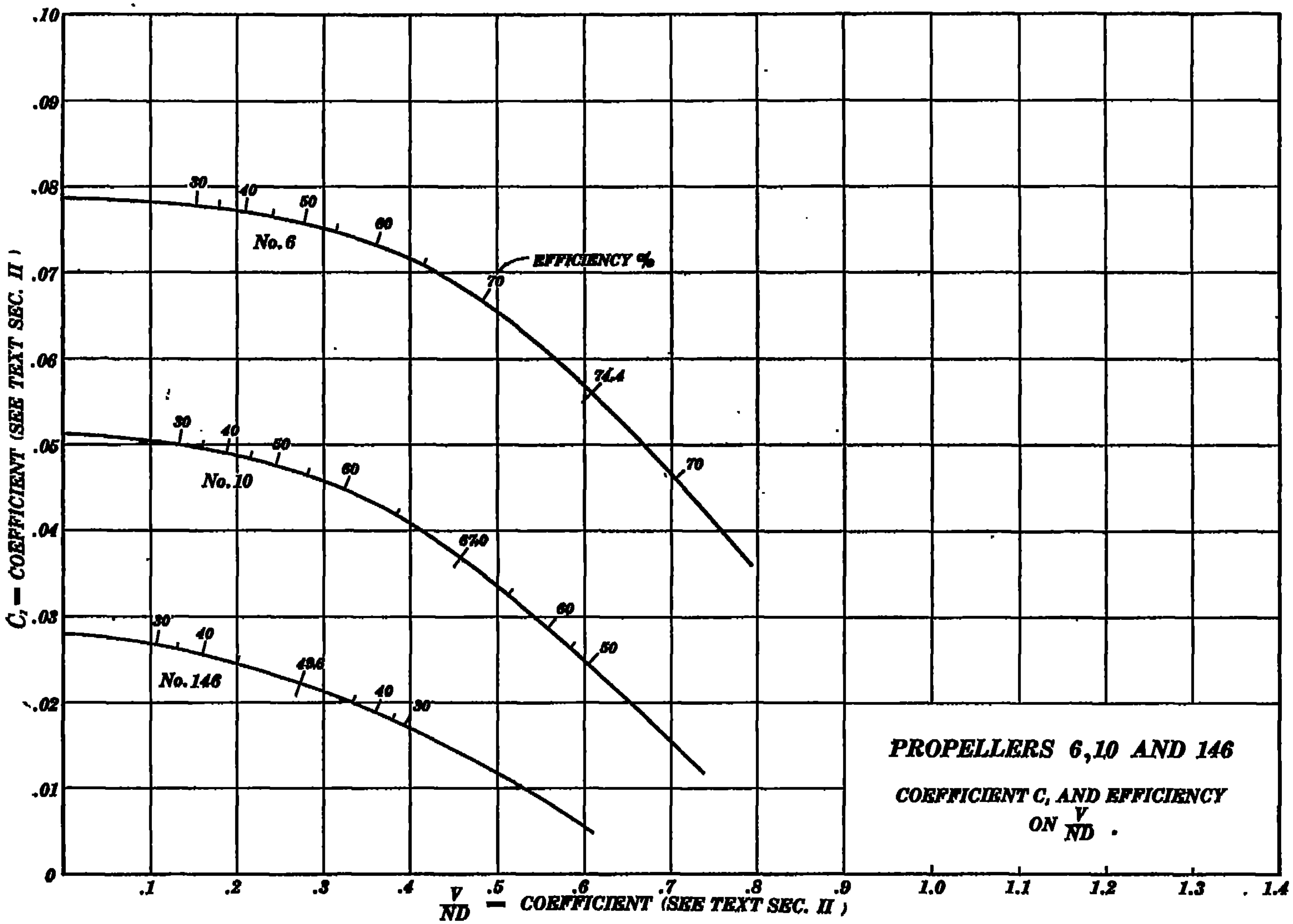

PROPELLERS 6, 10 AND 146
COEFFICIENT $C_s$ AND EFFICIENCY ON $\frac{V}{ND}$.
$C_s$ — COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ — COEFFICIENT (SEE TEXT SEC. II)
EFFICIENCY %
No. 6
No. 10
No. 146
74.4
67.0
49.6


FIG. 24.

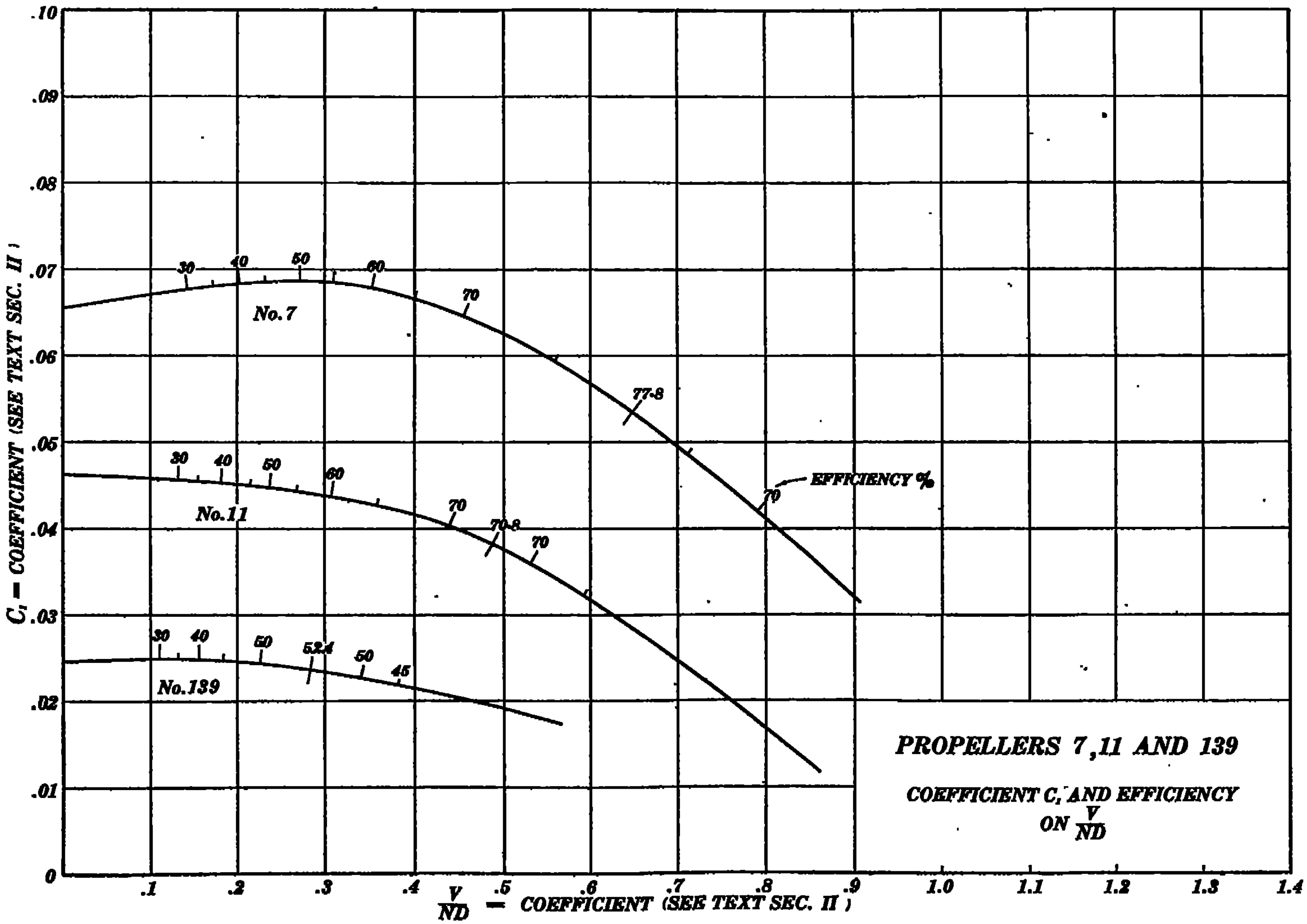

PROPELLERS 7, 11 AND 139
COEFFICIENT $C_t$ AND EFFICIENCY ON $\frac{V}{ND}$
$C_t$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)
No. 7
No. 11
No. 139
EFFICIENCY %
30
40
50
60
70
77-8
70-8
52.4
45
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4

FIG. 25.

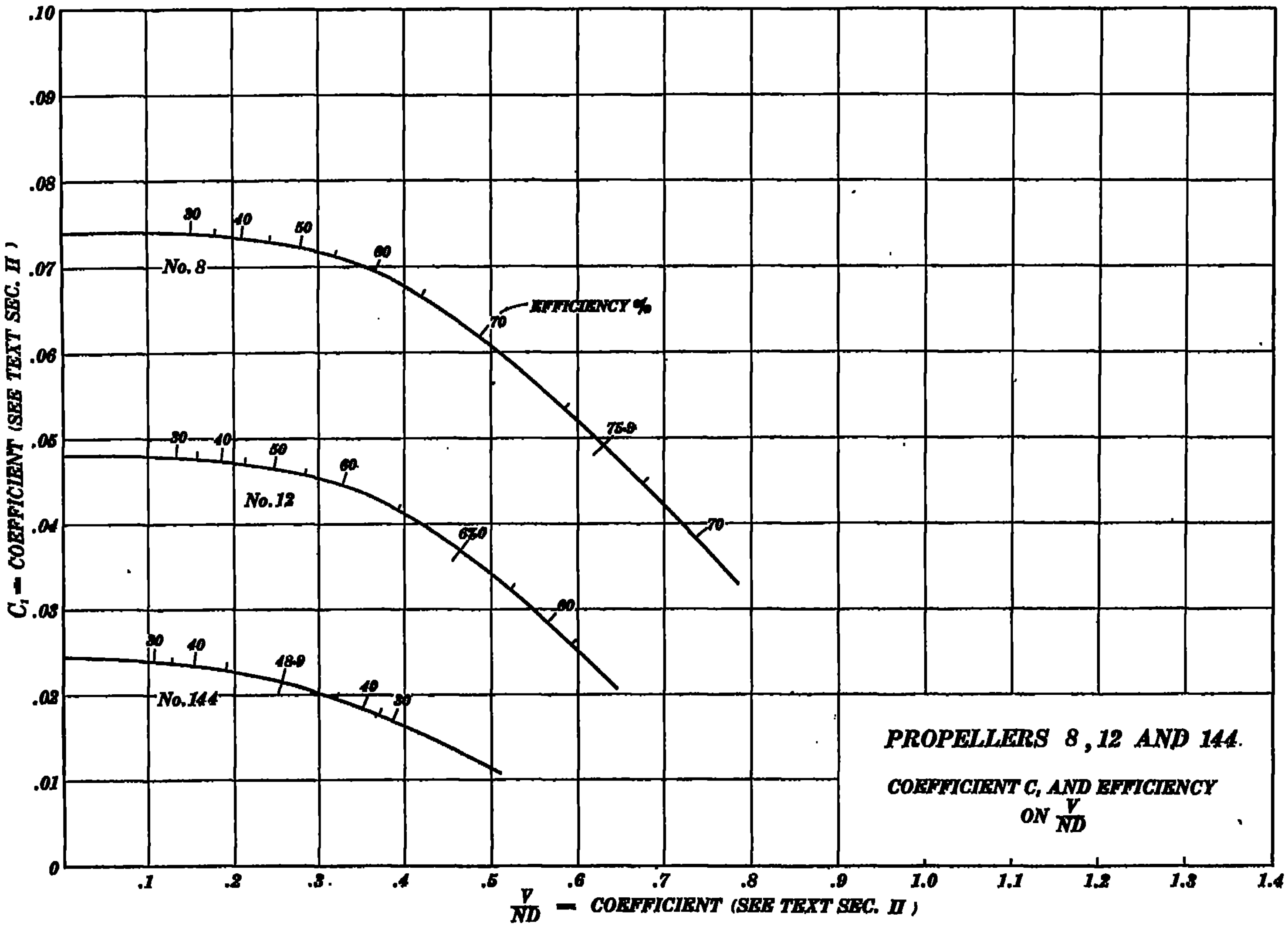

PROPELLERS 8, 12 AND 144.
COEFFICIENT $C_1$ AND EFFICIENCY ON $\frac{V}{ND}$
$C_1$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)
No. 8
No. 12
No. 144
EFFICIENCY %
75.9
67.0
48.9


FIG. 26.

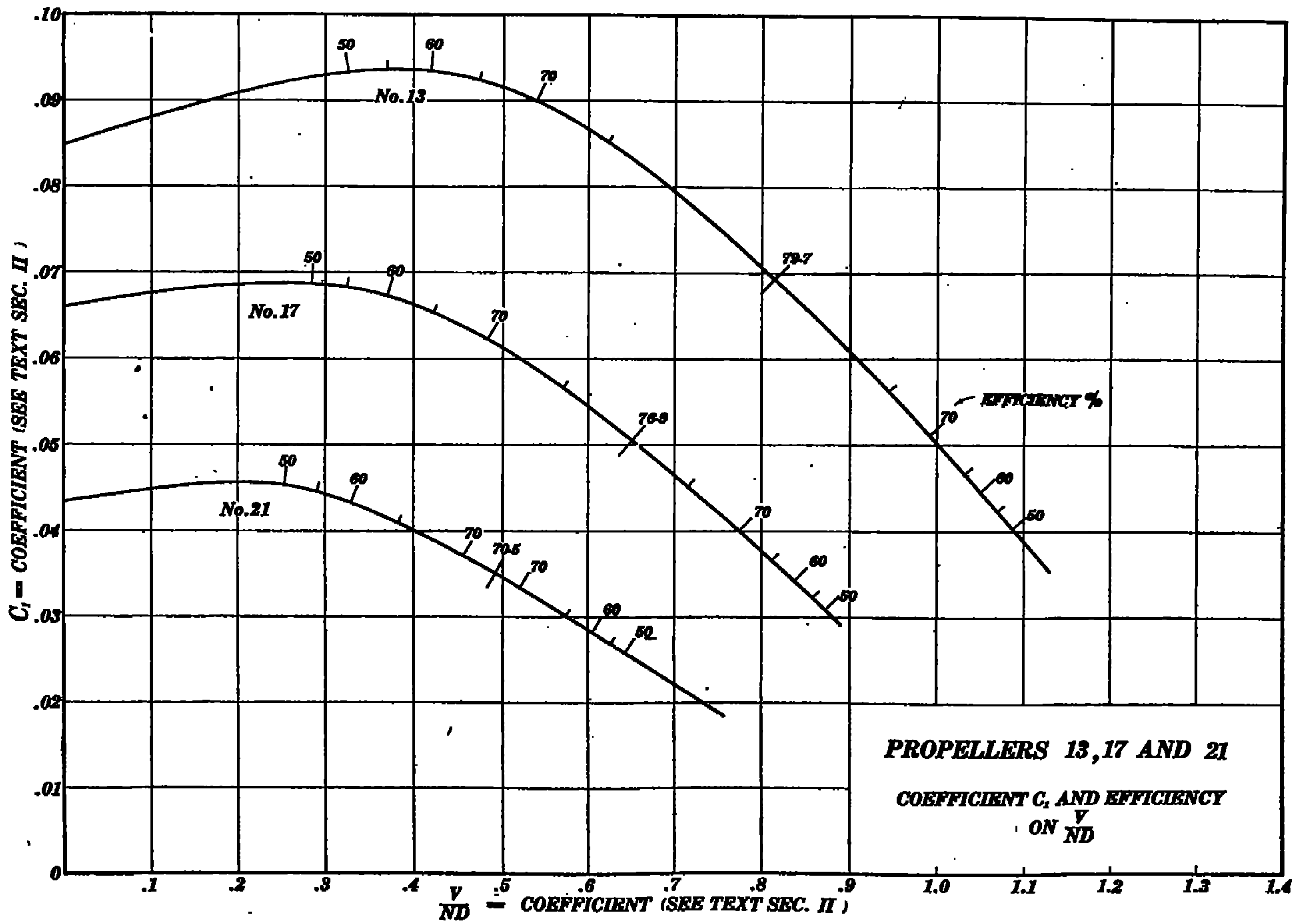

PROPELLERS 13,17 AND 21
COEFFICIENT $C_1$ AND EFFICIENCY ON $\frac{V}{ND}$
$C_1$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)
No. 13
No. 17
No. 21
EFFICIENCY %
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4
79.7
76.9
70.5

FIG. 27.

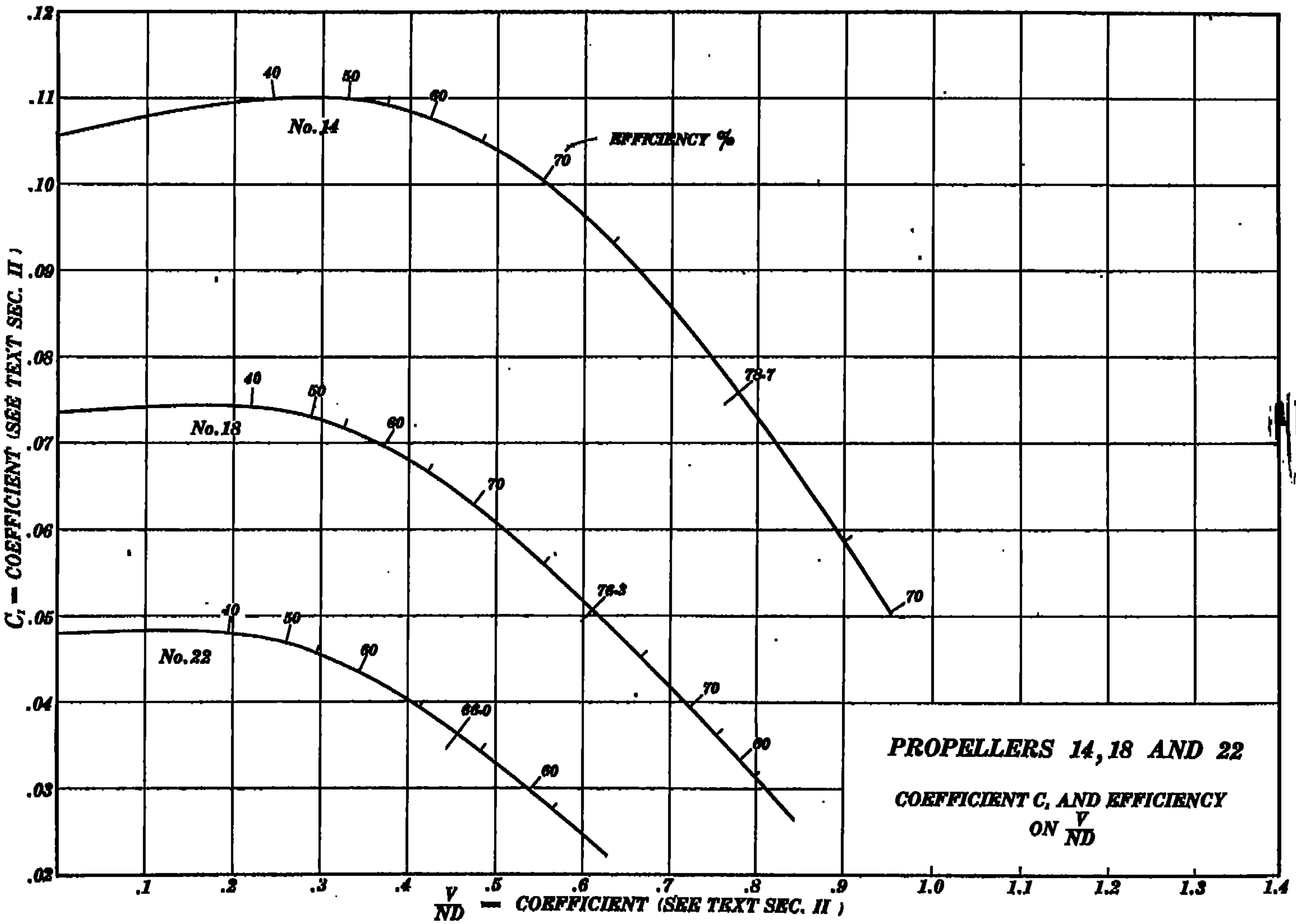

PROPELLERS 14, 18 AND 22
COEFFICIENT $C_t$ AND EFFICIENCY ON $\frac{V}{ND}$
$C_t$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ — COEFFICIENT (SEE TEXT SEC. II)
EFFICIENCY %
No. 14
No. 18
No. 22
40
50
60
70
78.7
76.3
66.0
.12
.11
.10
.09
.08
.07
.06
.05
.04
.03
.02
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4

FIG. 28.

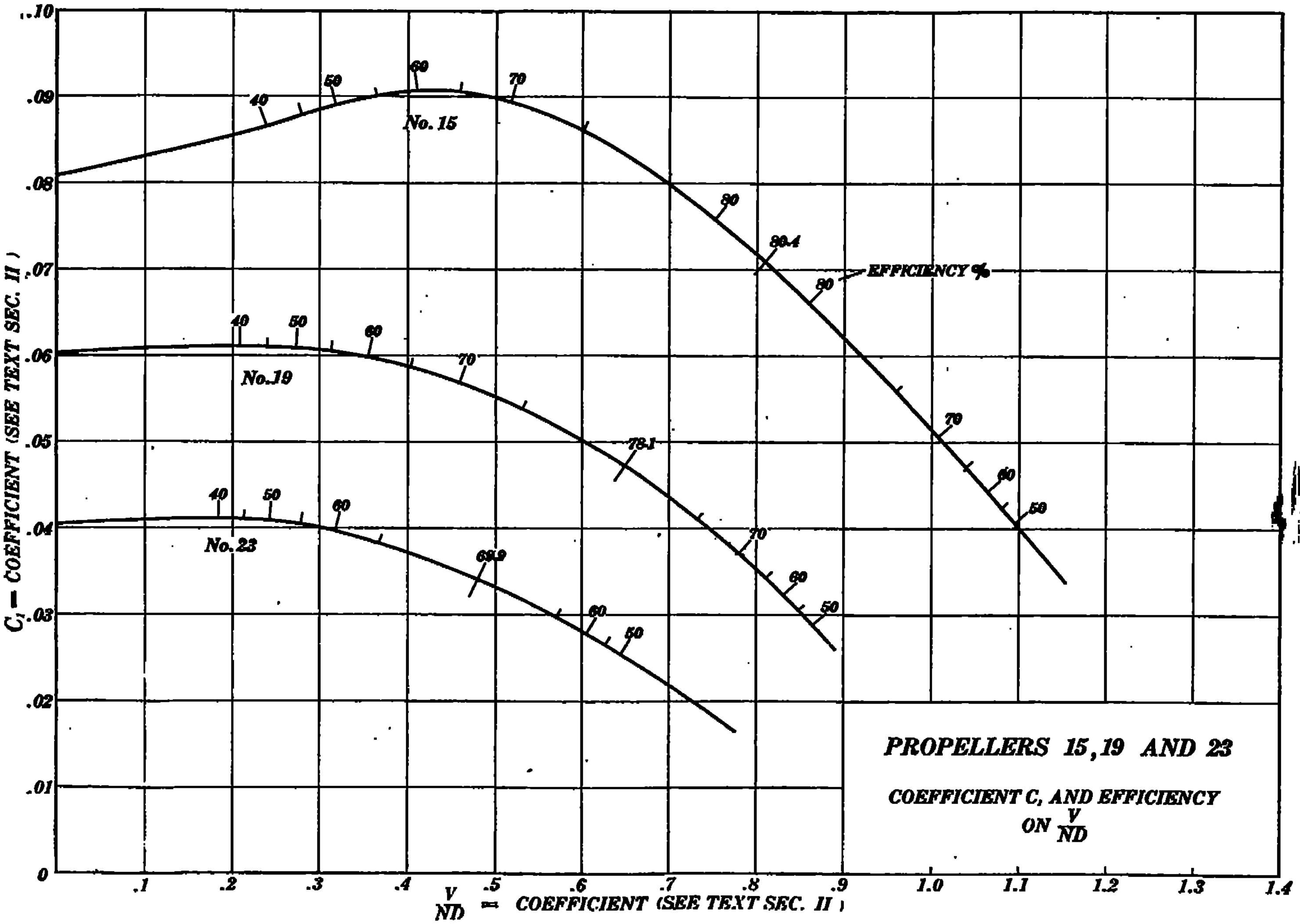

PROPELLERS 15, 19 AND 23
COEFFICIENT $C_1$ AND EFFICIENCY ON $\frac{V}{ND}$
$C_1$ — COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)
No. 15
No. 19
No. 23
EFFICIENCY %
80.4
78.1
69.9
0
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4

FIG. 29.

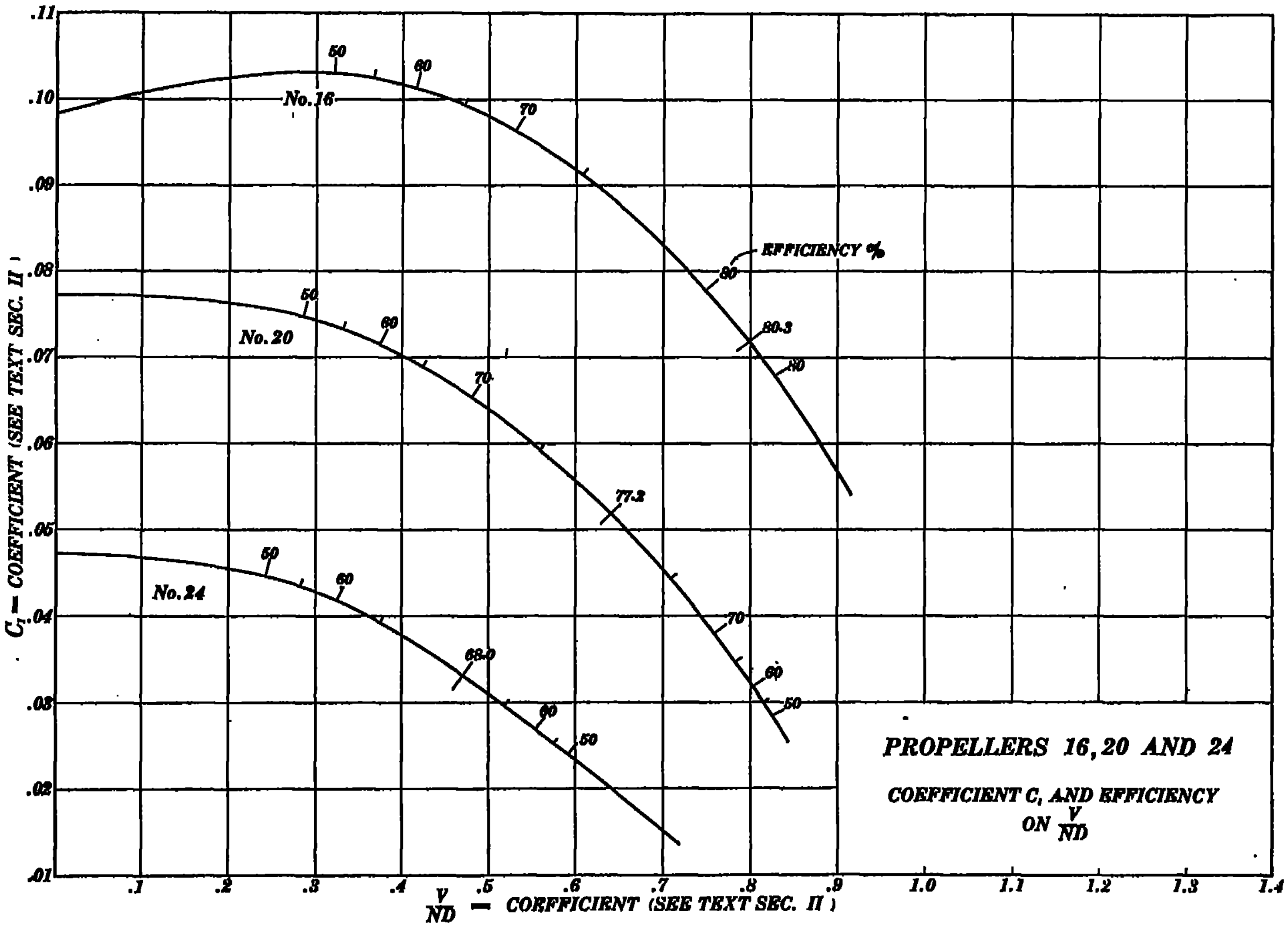

PROPELLERS 16,20 AND 24
COEFFICIENT $C_l$ AND EFFICIENCY ON $\frac{V}{ND}$
No. 16
No. 20
No. 24
EFFICIENCY %
80.3
77.2
68.0
$C_l$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)

Fig. 30.

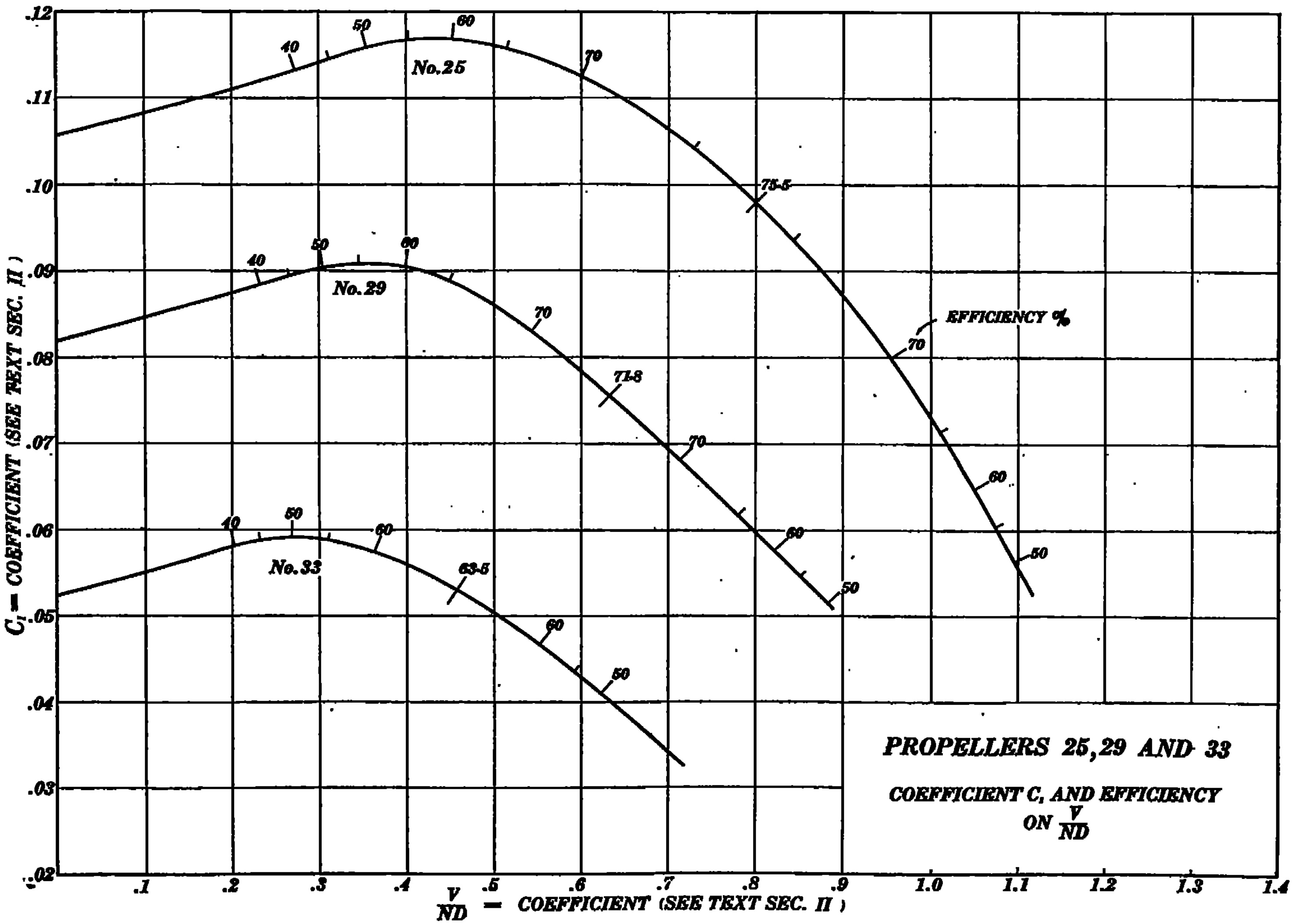

PROPELLERS 25,29 AND 33
COEFFICIENT $C_1$ AND EFFICIENCY ON $\frac{V}{ND}$
No. 25
No. 29
No. 33
EFFICIENCY %
$C_1$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)
.02
.03
.04
.05
.06
.07
.08
.09
.10
.11
.12
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4
40
50
60
70
75.5
71.8
63.5

FIG. 31.

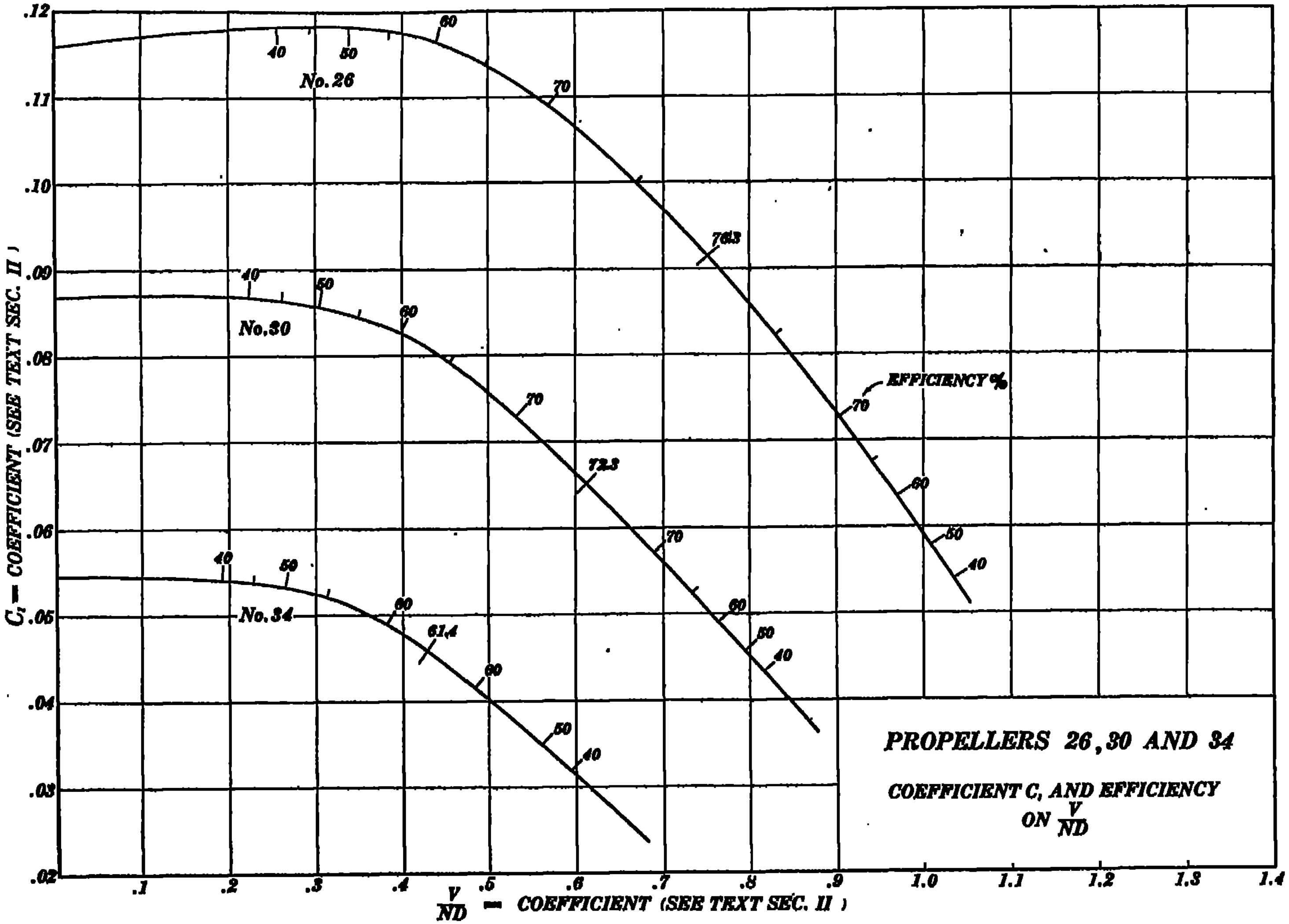

PROPELLERS 26, 30 AND 34
COEFFICIENT C, AND EFFICIENCY ON V/ND
No. 26
No. 30
No. 34
EFFICIENCY %
C, = COEFFICIENT (SEE TEXT SEC. II)
V/ND = COEFFICIENT (SEE TEXT SEC. II)
.12
.11
.10
.09
.08
.07
.06
.05
.04
.03
.02
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4
40
50
60
70
76.3
72.3
61.4

FIG. 32.

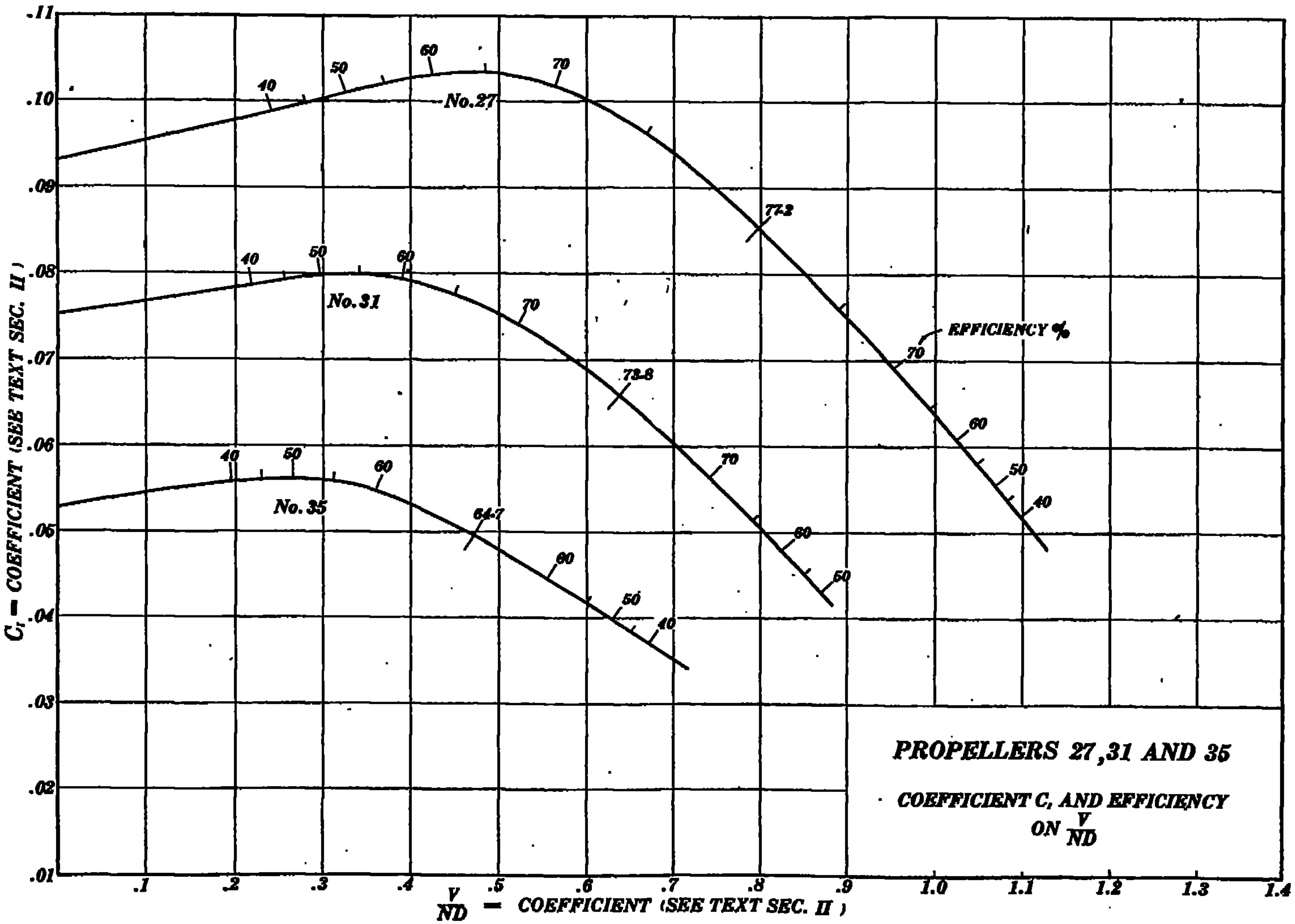

PROPELLERS 27,31 AND 35
COEFFICIENT $C_t$ AND EFFICIENCY ON $\frac{V}{ND}$
No. 27
No. 31
No. 35
EFFICIENCY %
77.2
73.8
64.7
$C_t$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
.11
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4

FIG. 33.

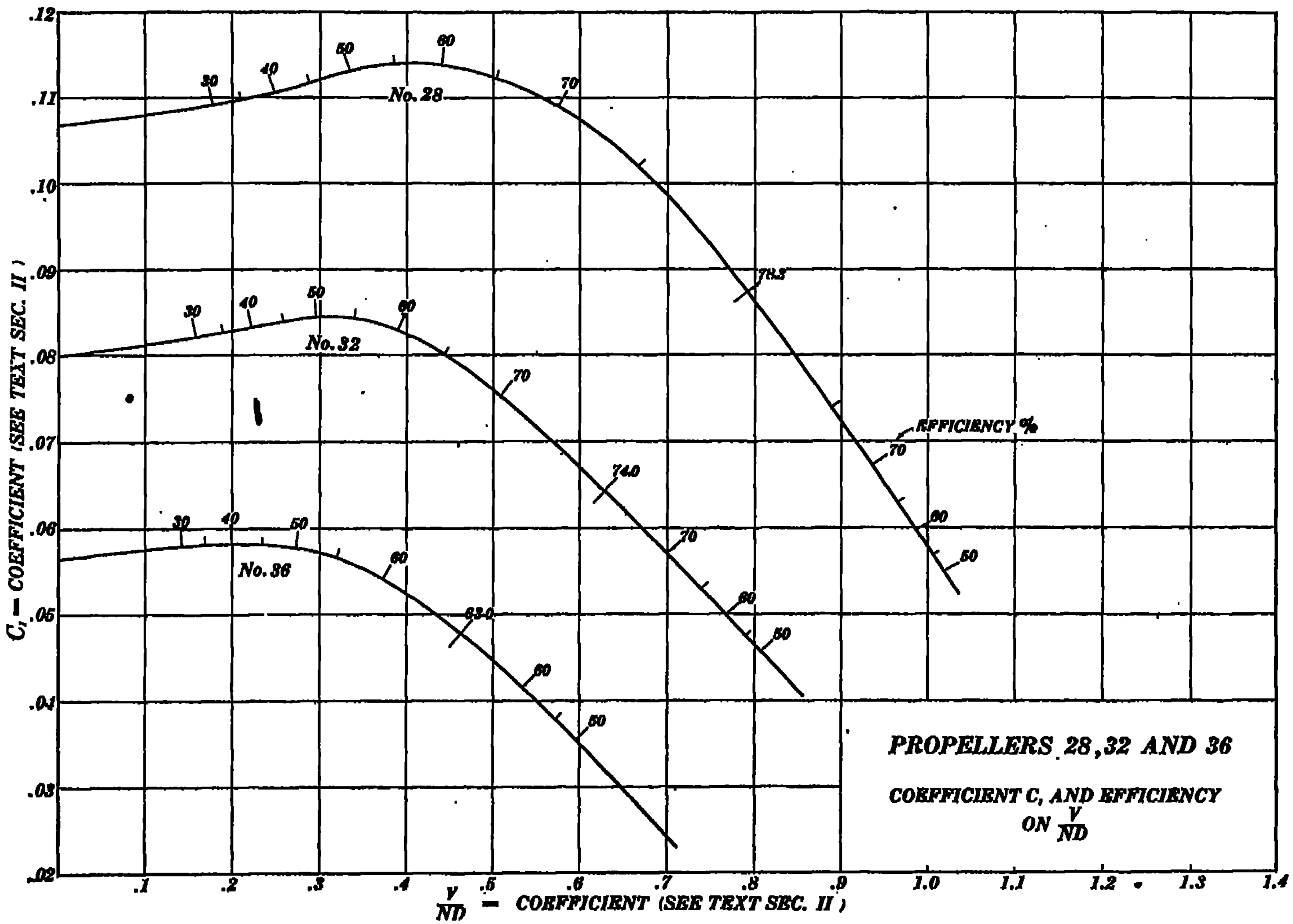

PROPELLERS 28, 32 AND 36
COEFFICIENT C1 AND EFFICIENCY ON V/ND
No. 28
No. 32
No. 36
EFFICIENCY %
78.3
74.0
63.0
C1 = COEFFICIENT (SEE TEXT SEC. II)
V/ND = COEFFICIENT (SEE TEXT SEC. II)
.02
.03
.04
.05
.06
.07
.08
.09
.10
.11
.12
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4

FIG. 34.

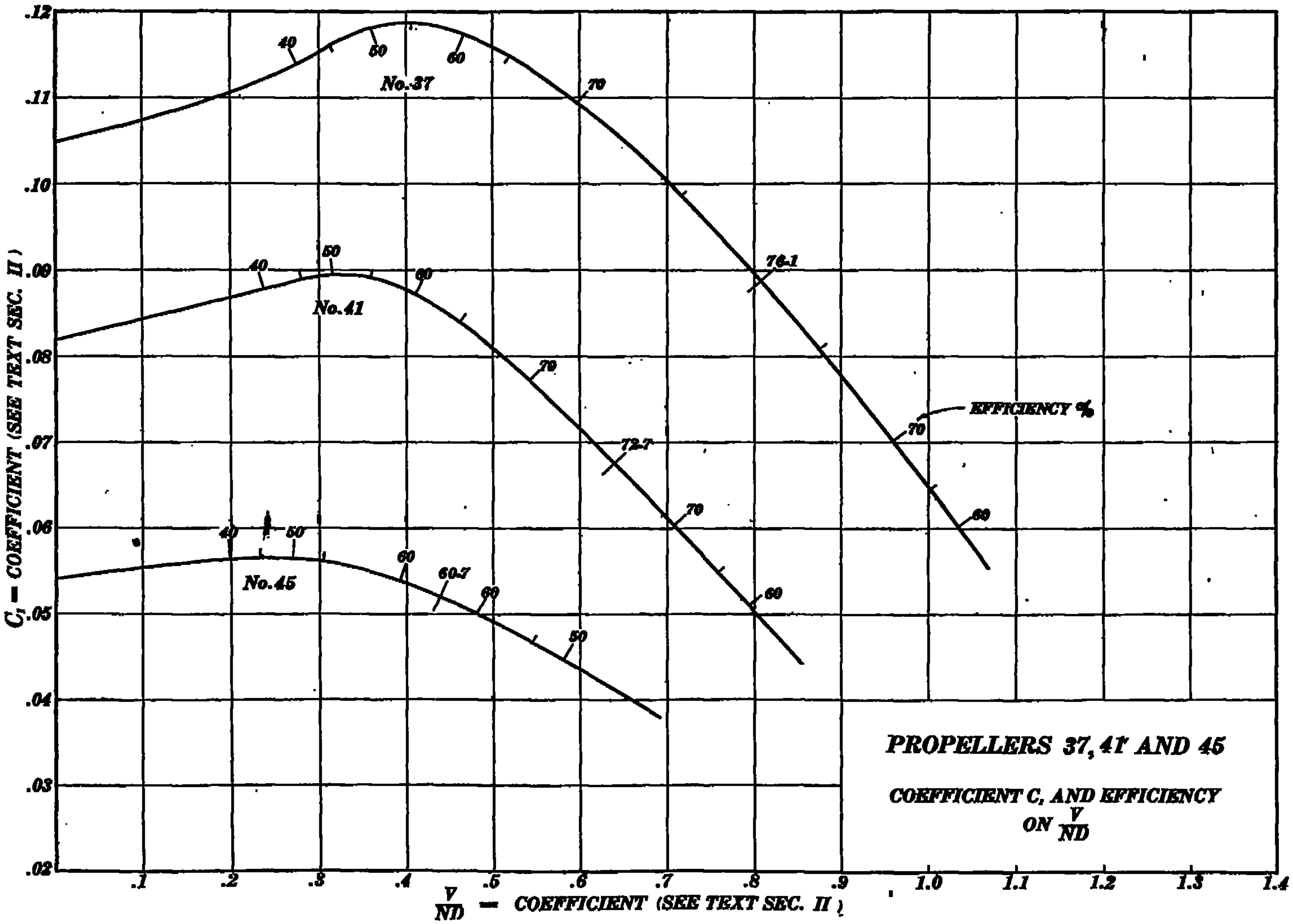

PROPELLERS 37, 41 AND 45
COEFFICIENT $C_t$ AND EFFICIENCY ON $\frac{V}{ND}$
No. 37
No. 41
No. 45
EFFICIENCY %
$C_t$ – COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ – COEFFICIENT (SEE TEXT SEC. II)
.02 .03 .04 .05 .06 .07 .08 .09 .10 .11 .12
.1 .2 .3 .4 .5 .6 .7 .8 .9 1.0 1.1 1.2 1.3 1.4
40 50 60 70 76.1 70 60
40 50 60 70 72.7 70 60
40 50 60 60.7 60 50

FIG. 35.

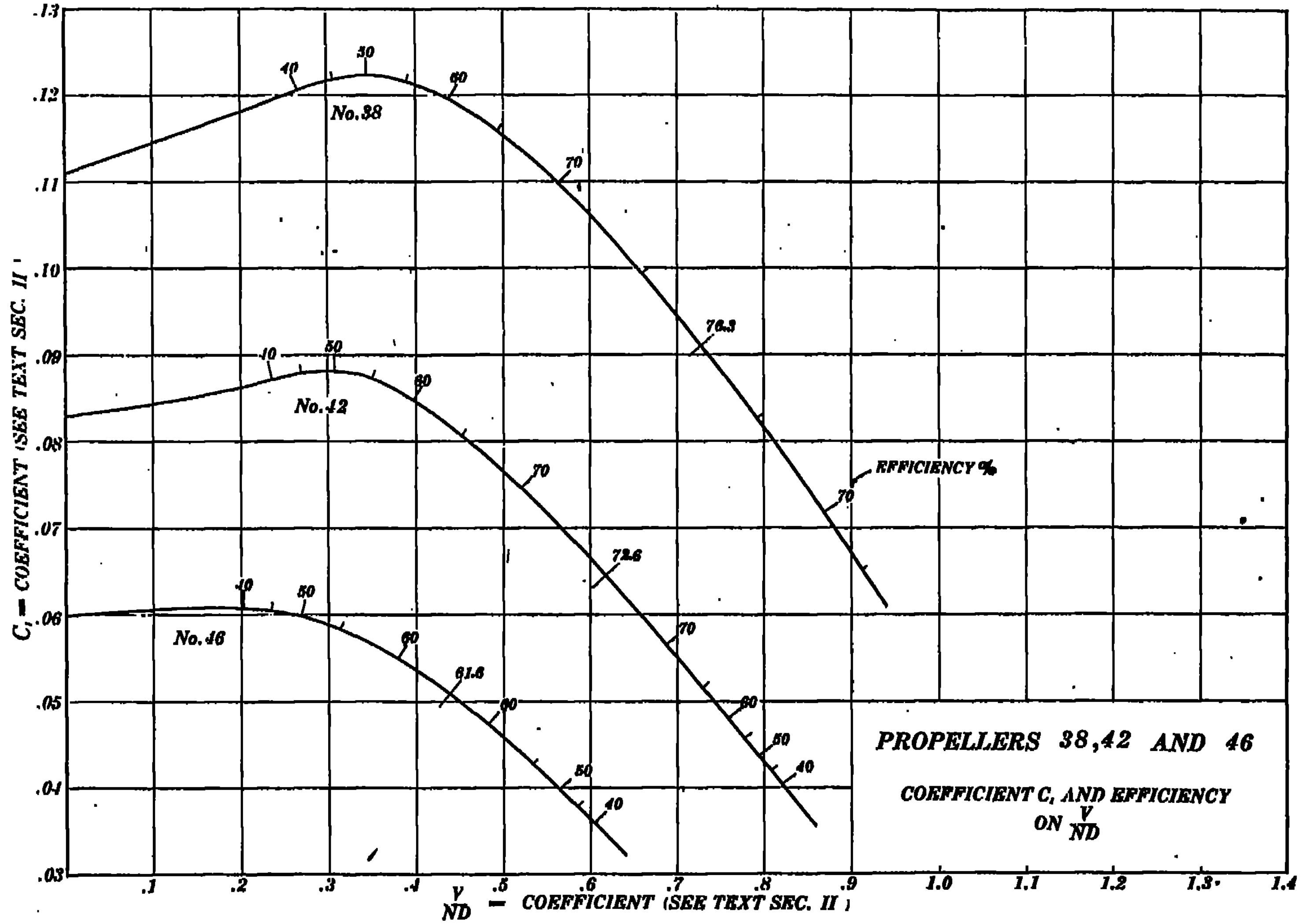

PROPELLERS 38,42 AND 46
COEFFICIENT C, AND EFFICIENCY ON V/ND
No. 38
No. 42
No. 46
EFFICIENCY %
C, = COEFFICIENT (SEE TEXT SEC. II)
V/ND = COEFFICIENT (SEE TEXT SEC. II)

FIG. 38.

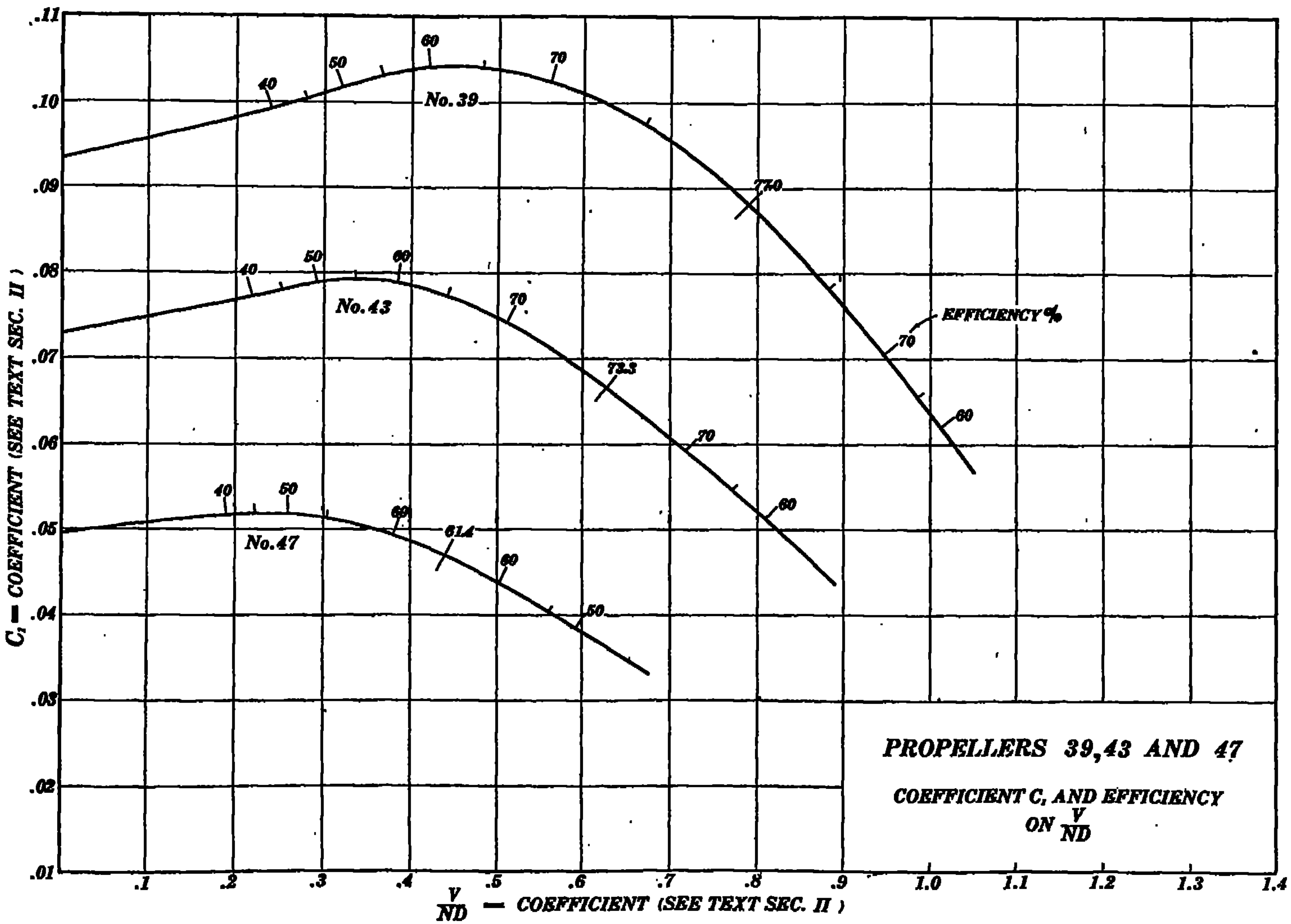

PROPELLERS 39,43 AND 47
COEFFICIENT $C_1$ AND EFFICIENCY ON $\frac{V}{ND}$
No. 39
No. 43
No. 47
EFFICIENCY %
$C_1$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ — COEFFICIENT (SEE TEXT SEC. II)
.11
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4

FIG. 37.

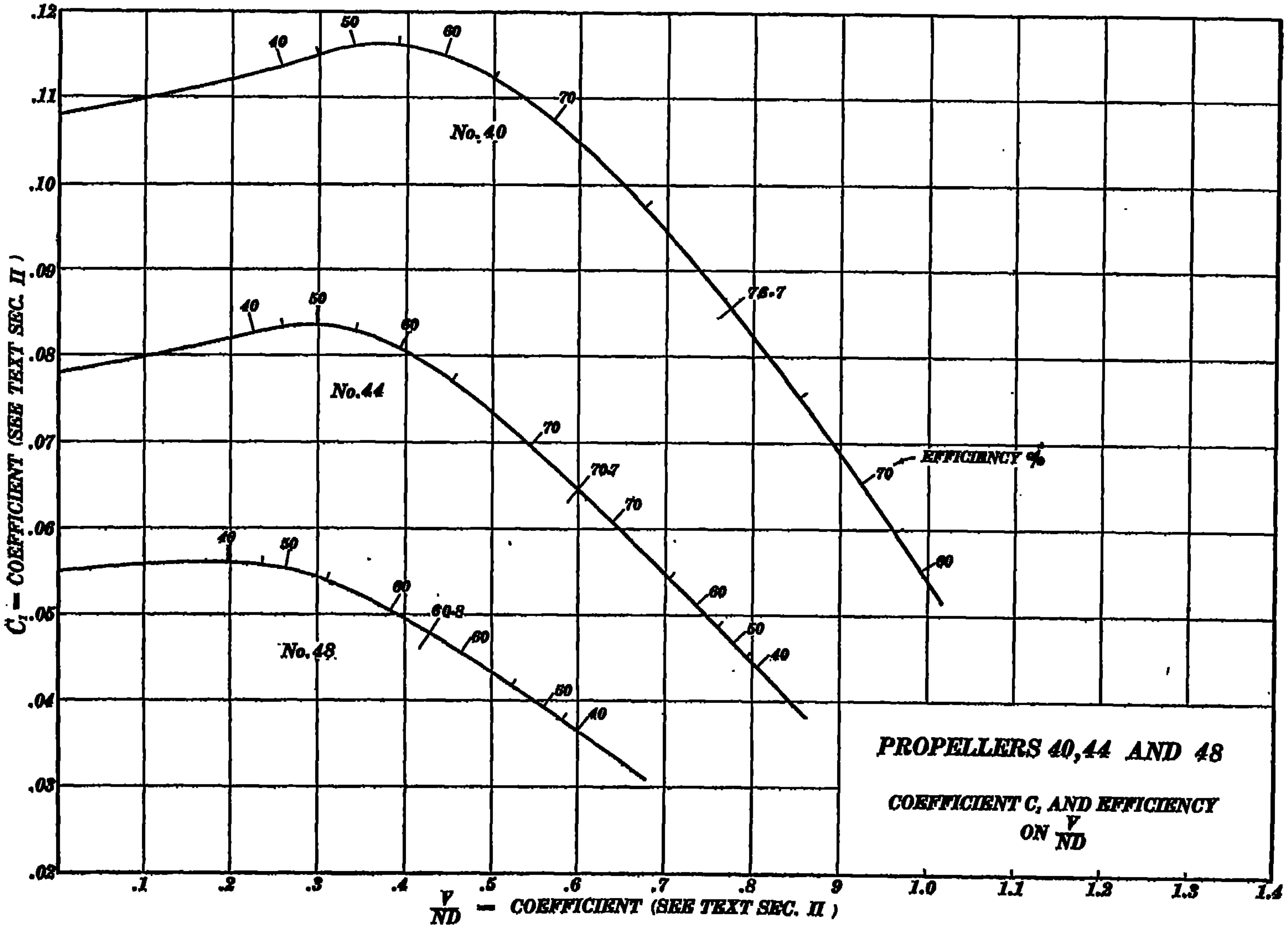

PROPELLERS 40,44 AND 48
COEFFICIENT $C_T$ AND EFFICIENCY ON $\frac{V}{ND}$
$C_T$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)
No. 40
No. 44
No. 48
EFFICIENCY %
.12
.11
.10
.09
.08
.07
.06
.05
.04
.03
.02
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4

Fig. 38.

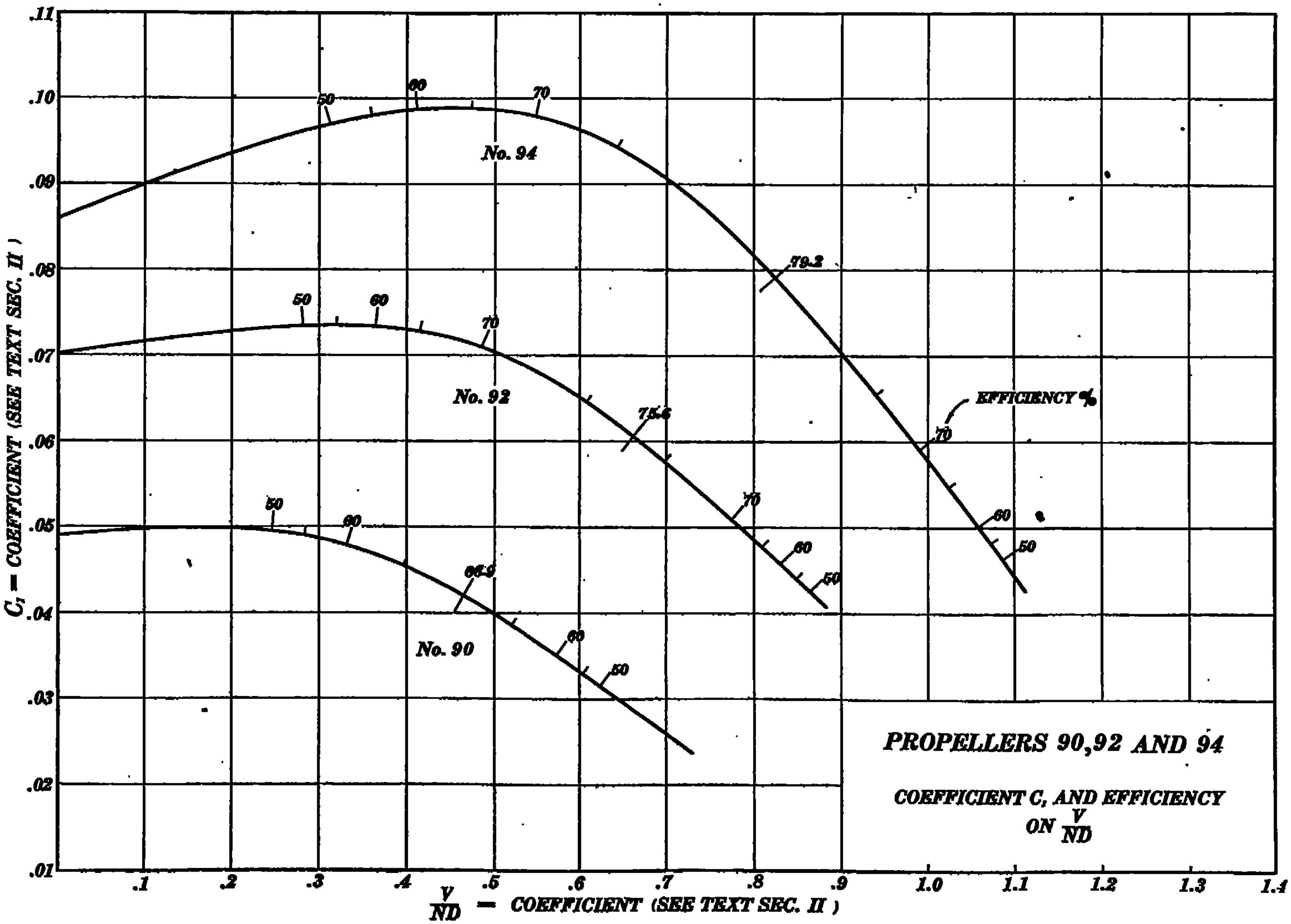

PROPELLERS 90,92 AND 94
COEFFICIENT $C_l$ AND EFFICIENCY ON $\frac{V}{ND}$
$C_l$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)
No. 94
No. 92
No. 90
EFFICIENCY %
79.2
75.6
66.9
50
60
70
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
.11
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4

FIG. 30.

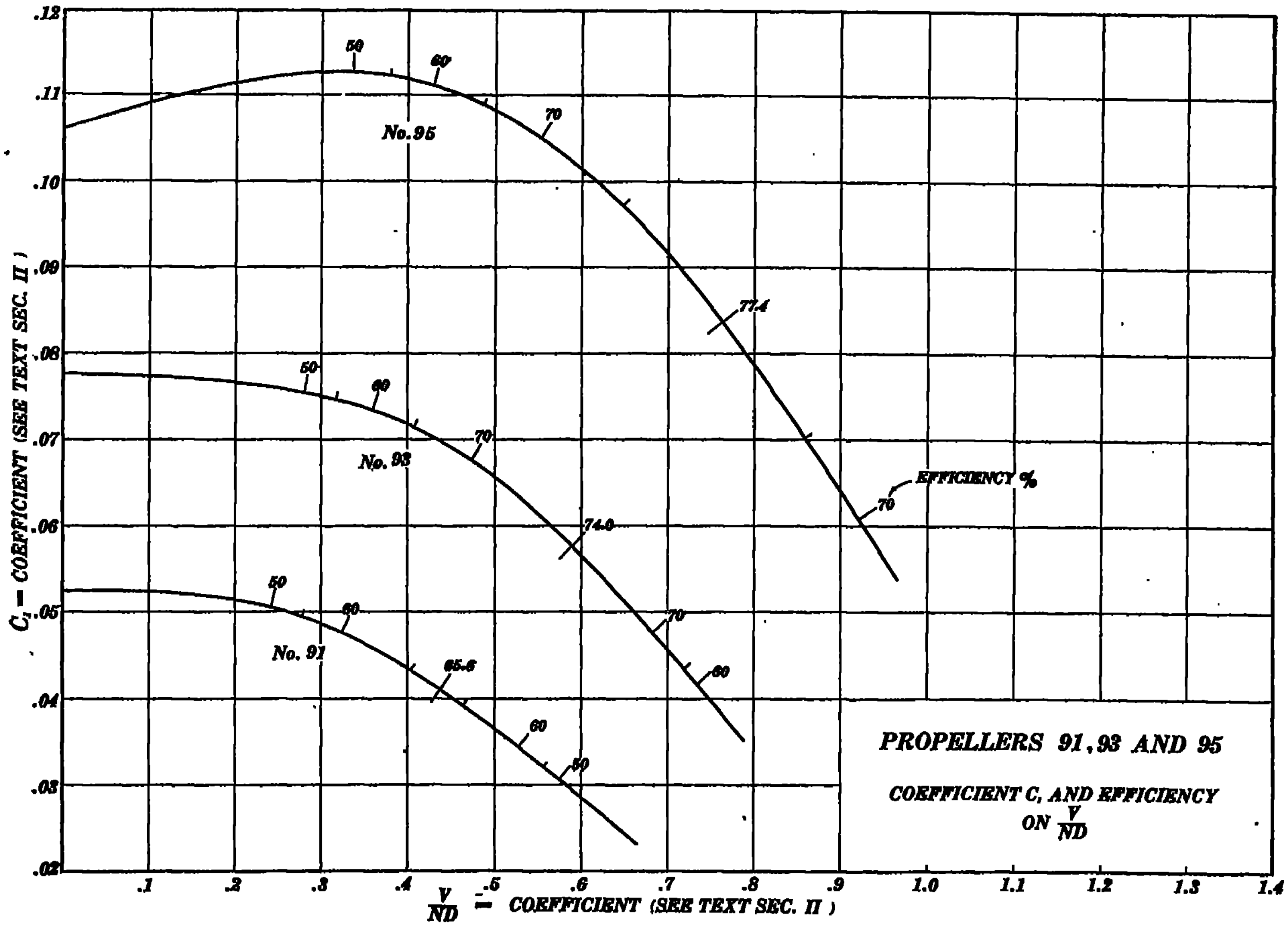

PROPELLERS 91, 93 AND 95
COEFFICIENT $C_t$ AND EFFICIENCY ON $\frac{V}{ND}$
$C_t$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)
No. 95
No. 93
No. 91
EFFICIENCY %
50
60
70
77.4
74.0
65.6
.02
.03
.04
.05
.06
.07
.08
.09
.10
.11
.12
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4

FIG. 40.

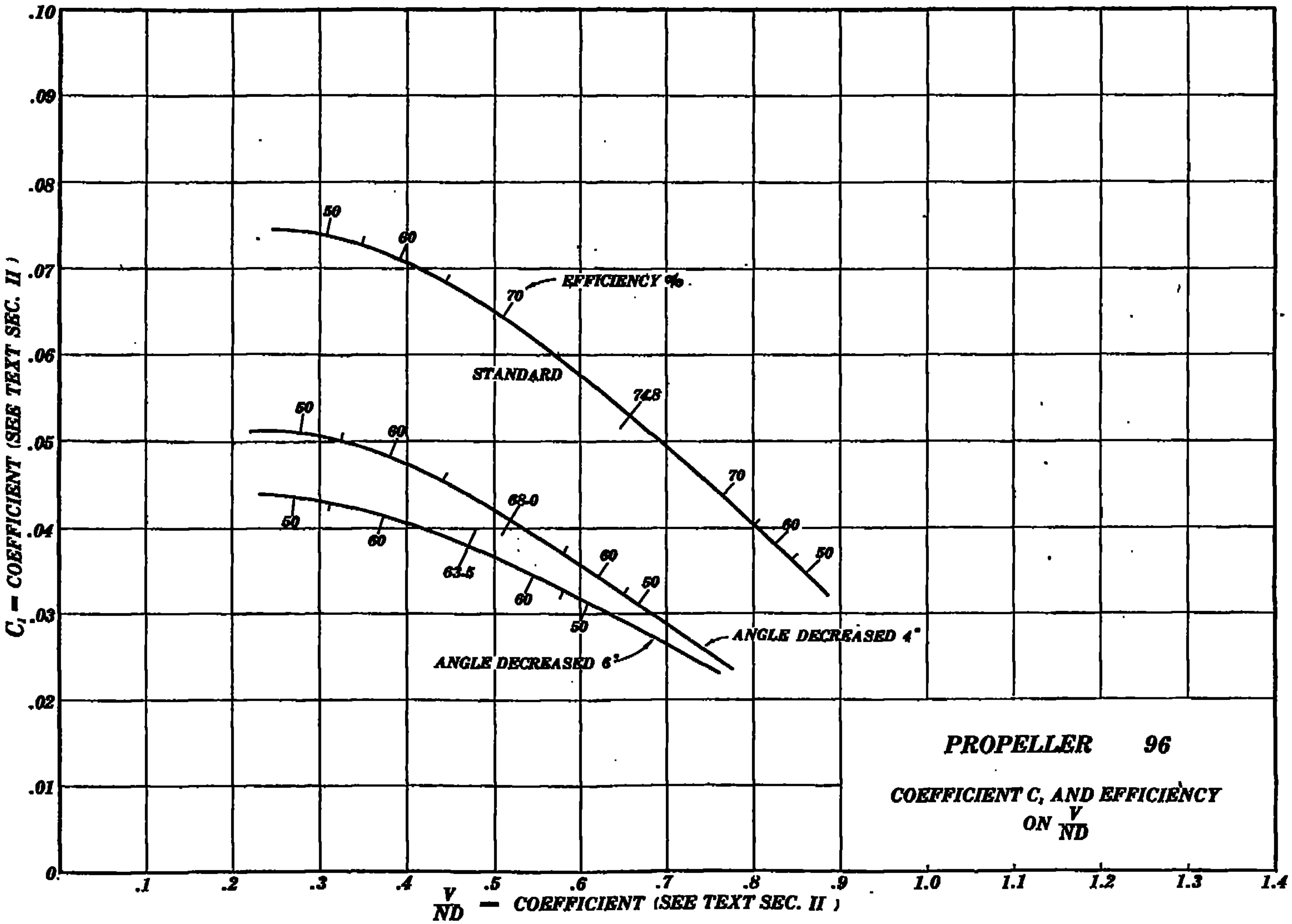

PROPELLER 96
COEFFICIENT $C_l$ AND EFFICIENCY ON $\frac{V}{ND}$
EFFICIENCY %
STANDARD
ANGLE DECREASED 4°
ANGLE DECREASED 6°
50
60
70
74.8
70
60
50
50
60
68.0
60
50
50
60
63.5
60
50
$C_l$ — COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ — COEFFICIENT (SEE TEXT SEC. II)
0
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4

FIG. 41.

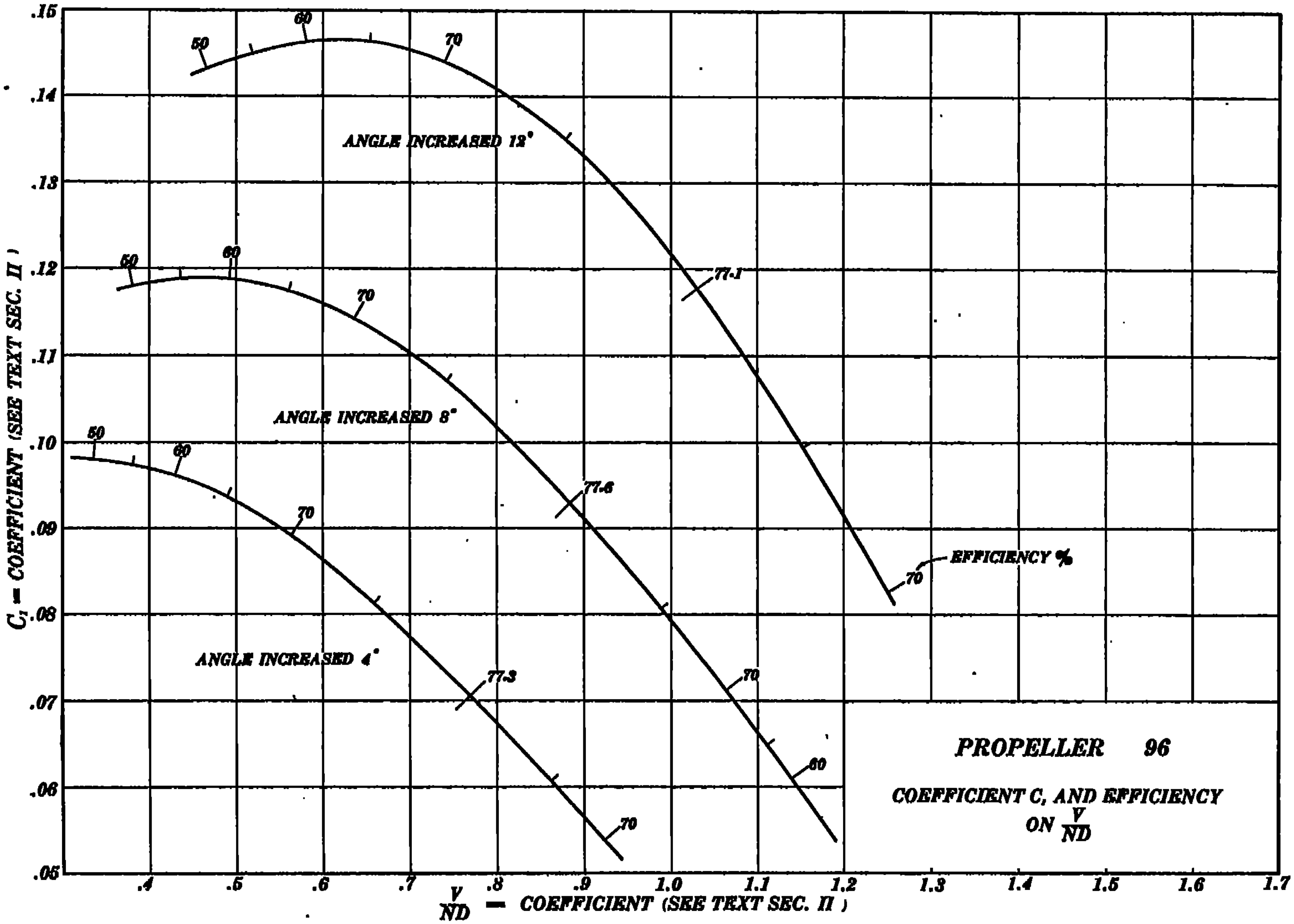

.15
.14
.13
.12
.11
.10
.09
.08
.07
.06
.05
$C_T$ = COEFFICIENT (SEE TEXT SEC. II)
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)
ANGLE INCREASED 12°
ANGLE INCREASED 8°
ANGLE INCREASED 4°
50
60
70
77.1
77.6
77.3
EFFICIENCY %
PROPELLER 96
COEFFICIENT $C_T$ AND EFFICIENCY ON $\frac{V}{ND}$

FIG. 42.

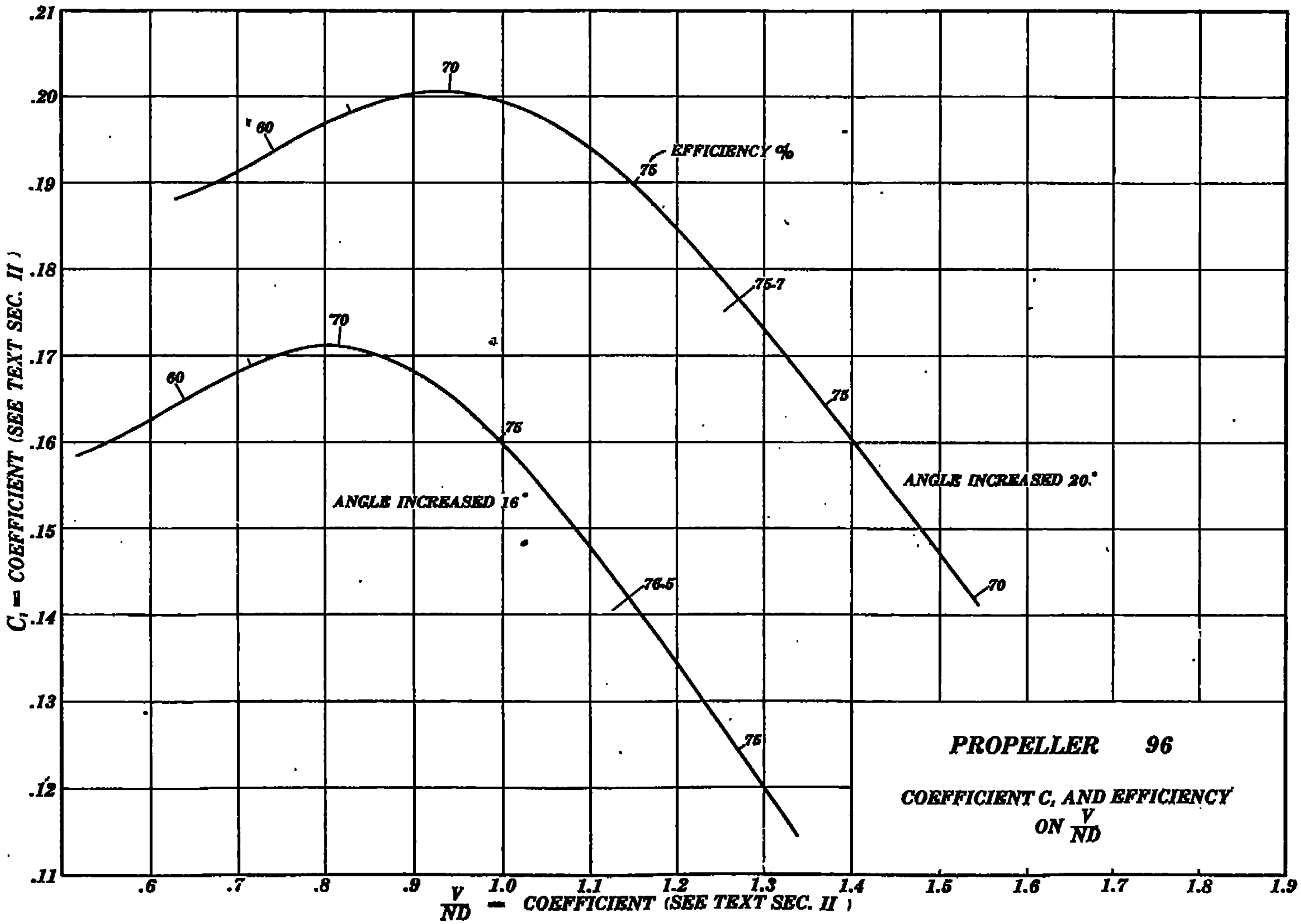

PROPELLER 96
COEFFICIENT $C_1$ AND EFFICIENCY ON $\frac{V}{ND}$
$C_1$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)
EFFICIENCY %
ANGLE INCREASED 16°
ANGLE INCREASED 20°
60
70
75
75-7
76.5
.11
.12
.13
.14
.15
.16
.17
.18
.19
.20
.21
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9

FIG. 43.

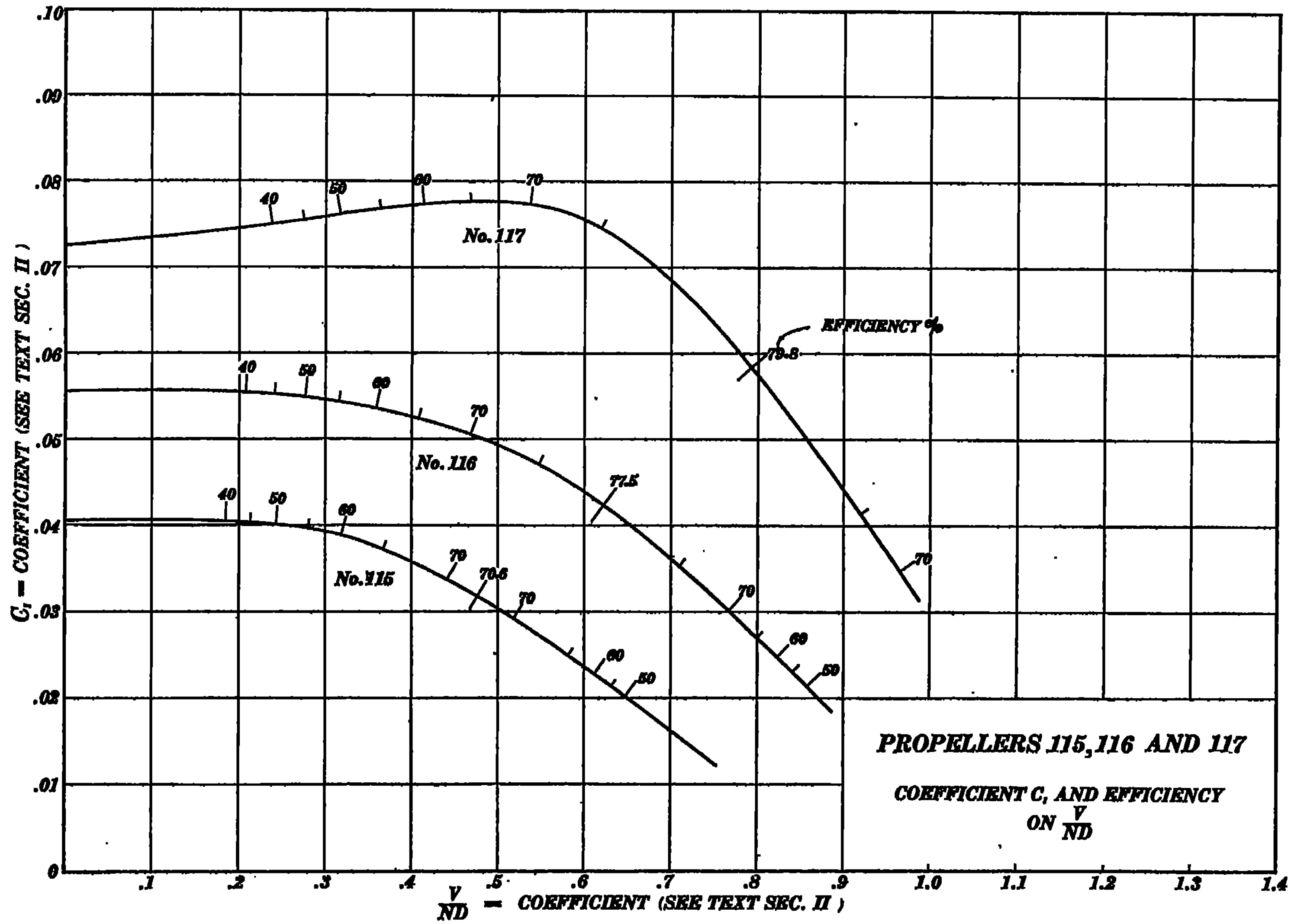

PROPELLERS 115, 116 AND 117
COEFFICIENT $C_l$ AND EFFICIENCY ON $\frac{V}{ND}$
No. 117
No. 116
No. 115
EFFICIENCY %
$C_l$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)


FIG. 44.

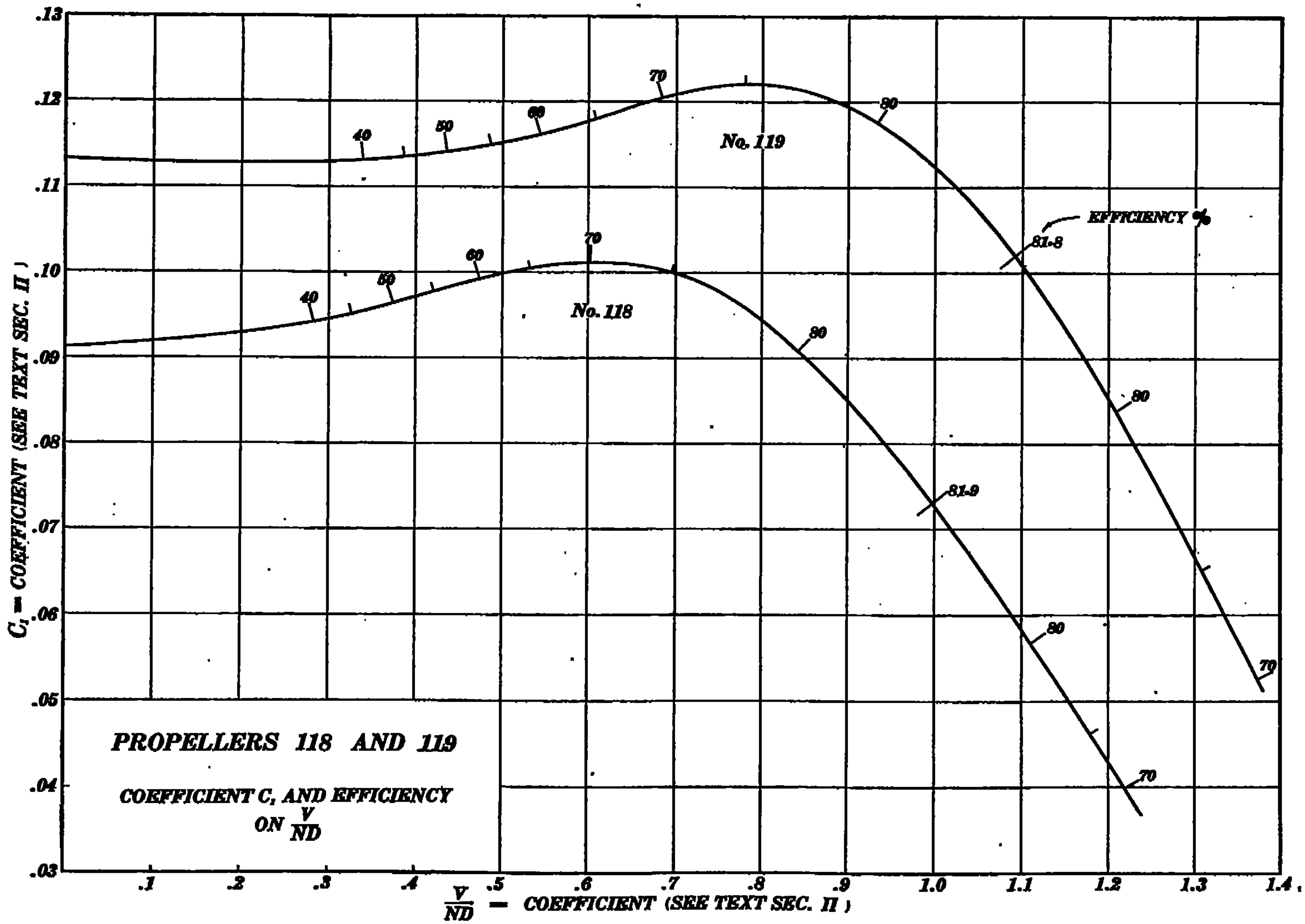

PROPELLERS 118 AND 119
COEFFICIENT $C_1$ AND EFFICIENCY ON $\frac{V}{ND}$
No. 119
No. 118
EFFICIENCY %
$C_1$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)
.13
.12
.11
.10
.09
.08
.07
.06
.05
.04
.03
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4
40
50
60
70
80
81.8
81.9

FIG. 5

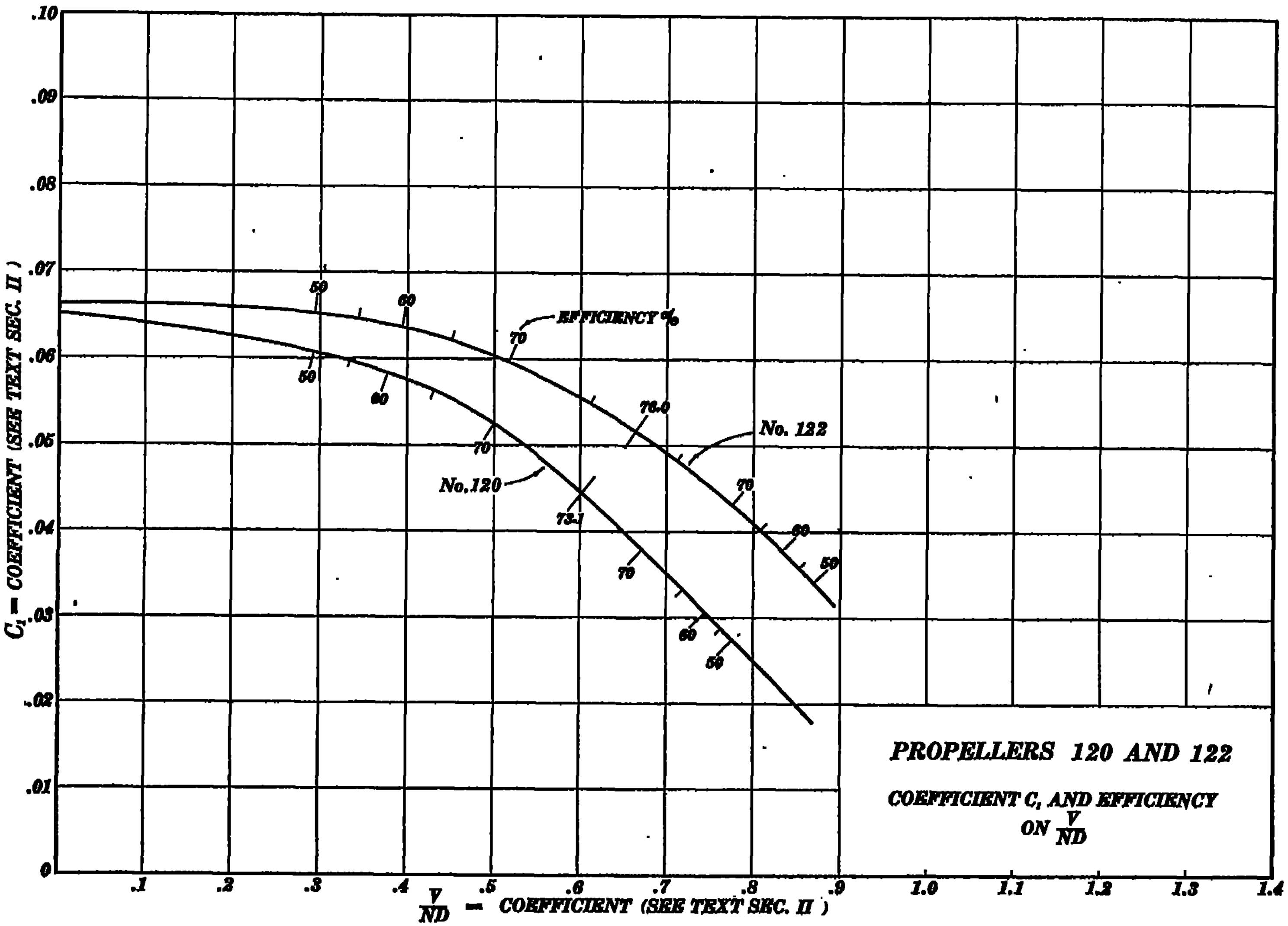

PROPELLERS 120 AND 122
COEFFICIENT $C_1$ AND EFFICIENCY ON $\frac{V}{ND}$
$C_1$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)
No. 120
No. 122
EFFICIENCY %
73.1
76.0
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4

FIG. 46.

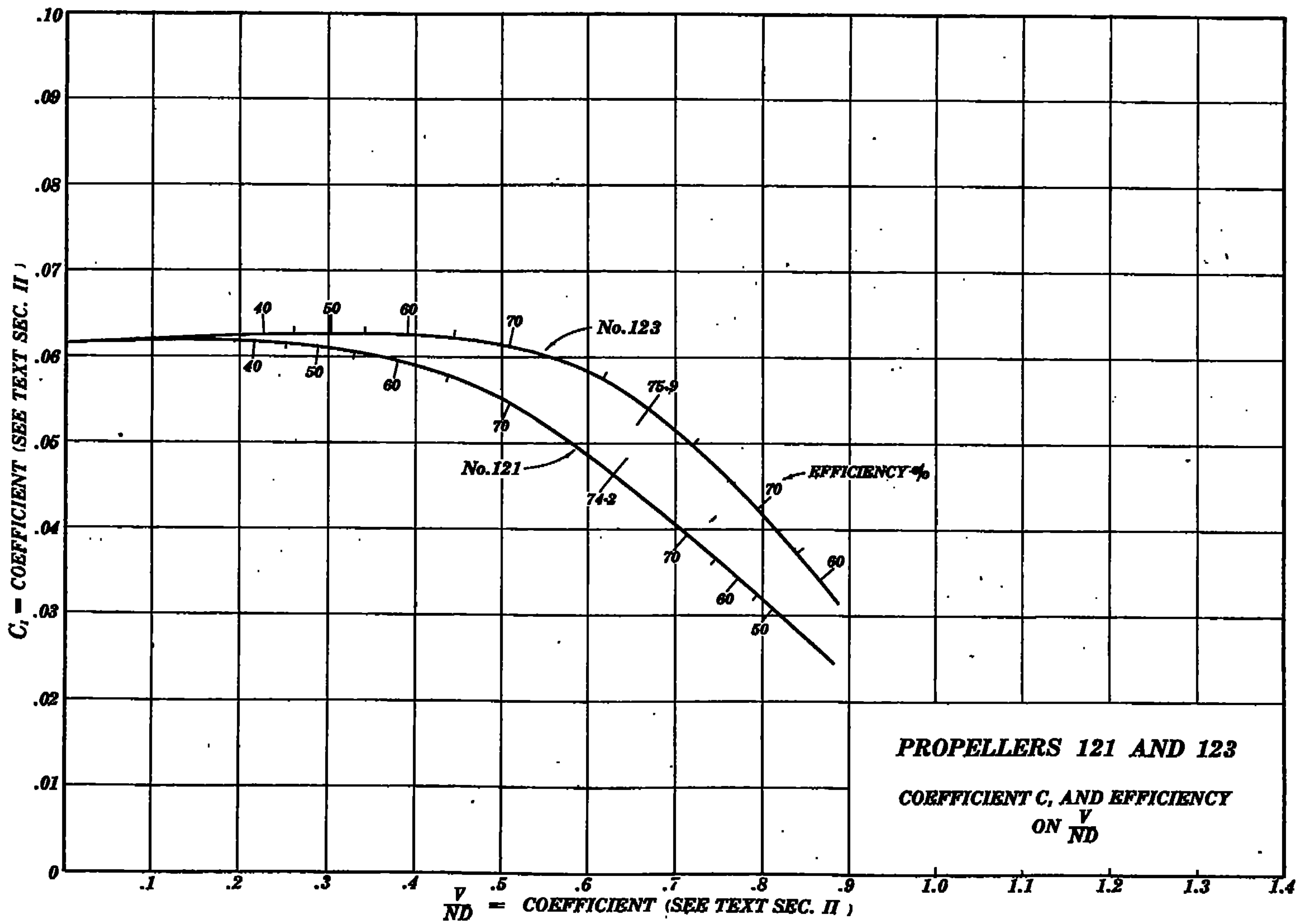

PROPELLERS 121 AND 123
COEFFICIENT $C_t$ AND EFFICIENCY ON $\frac{V}{ND}$
No. 123
No. 121
EFFICIENCY %
75.9
74.2
$C_t$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)

FIG. 47

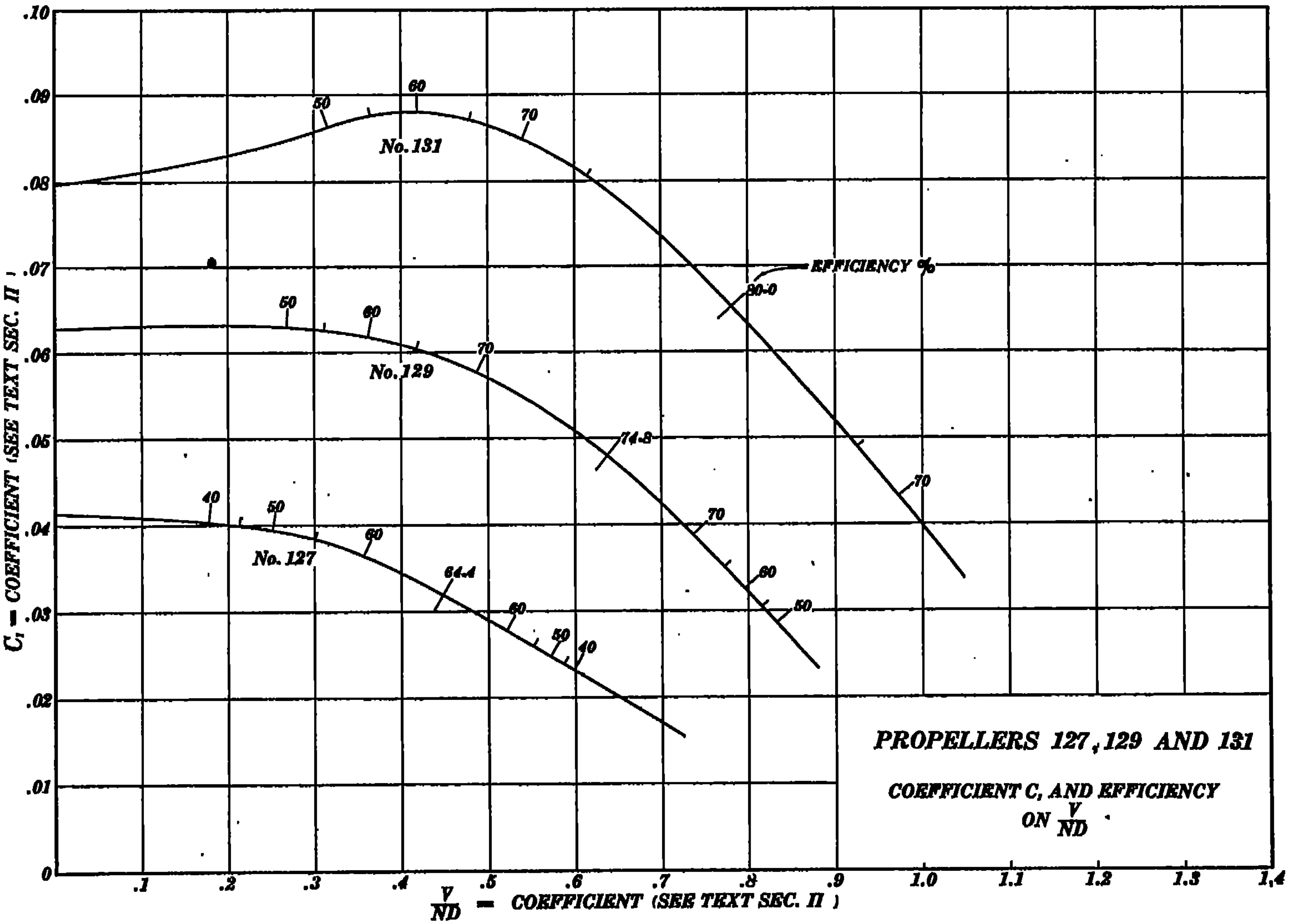

PROPELLERS 127, 129 AND 131
COEFFICIENT $C_t$ AND EFFICIENCY ON $\frac{V}{ND}$
$C_T$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)
No. 131
No. 129
No. 127
EFFICIENCY %
80.0
74.8
64.4


Fig. 48.

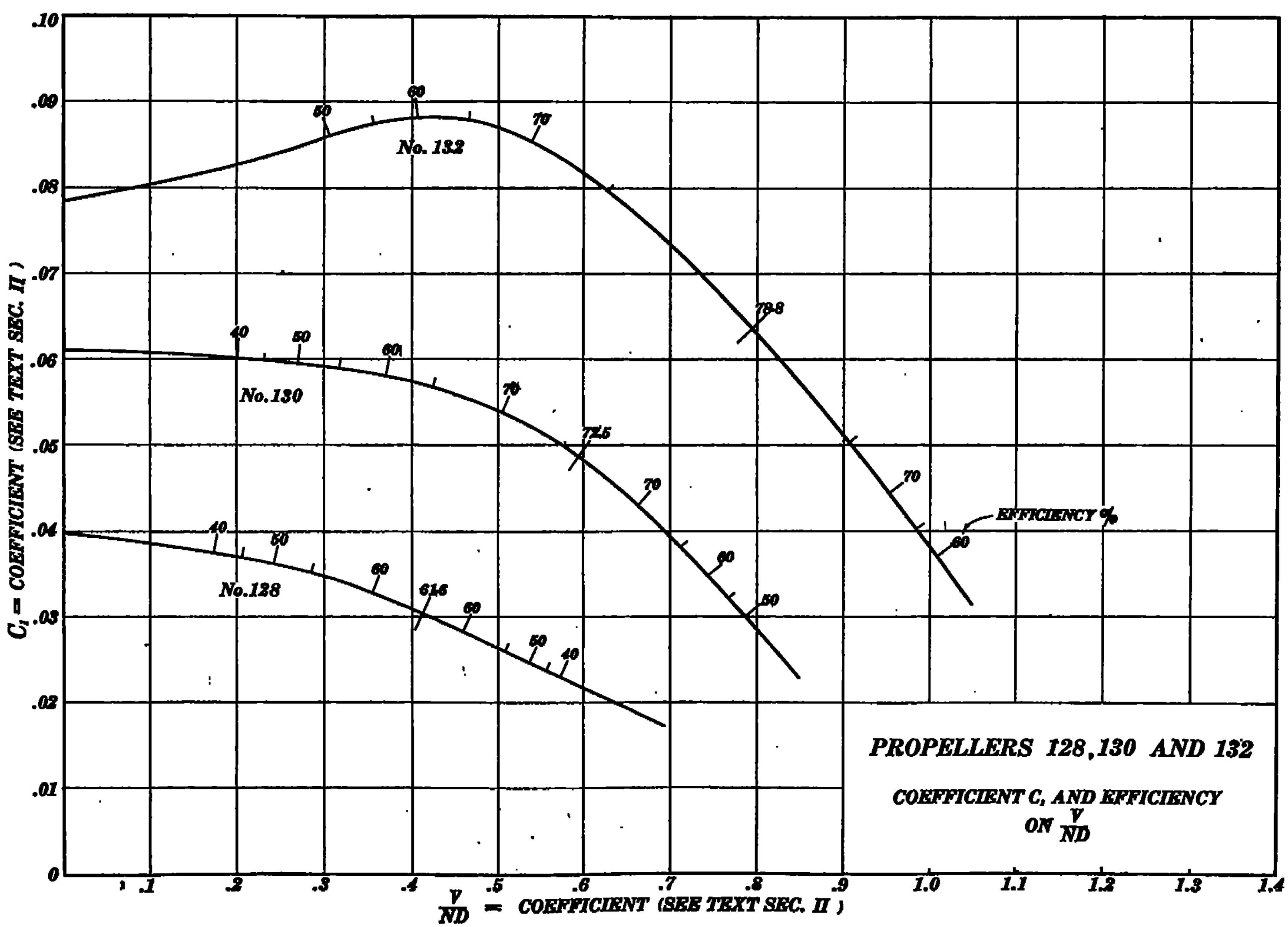

PROPELLERS 128, 130 AND 132
COEFFICIENT $C_l$ AND EFFICIENCY ON $\frac{V}{ND}$
$C_l$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)
No. 132
No. 130
No. 128
EFFICIENCY %
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4

Fig. 49.

53906—23—16

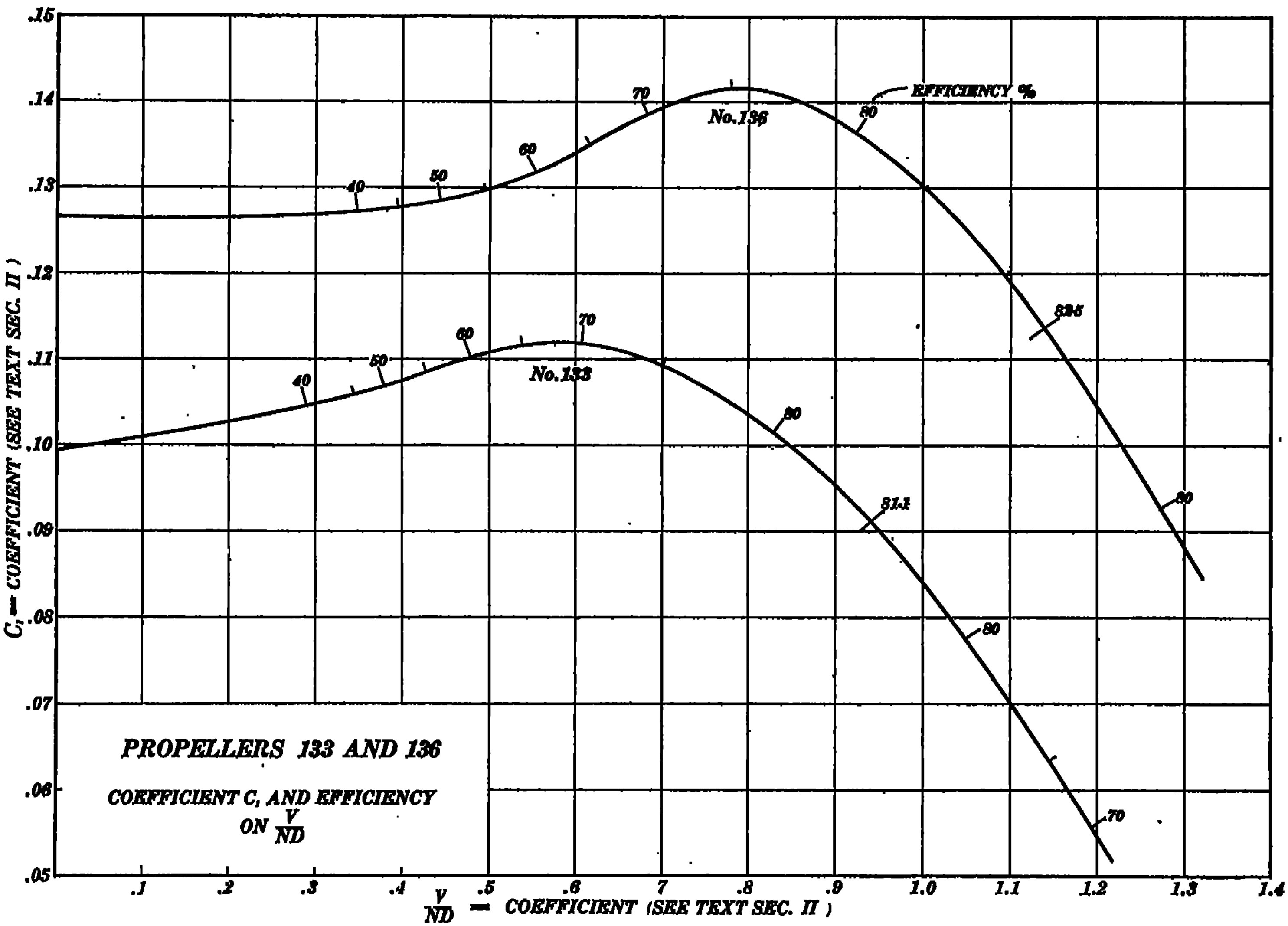



FIG. 50.

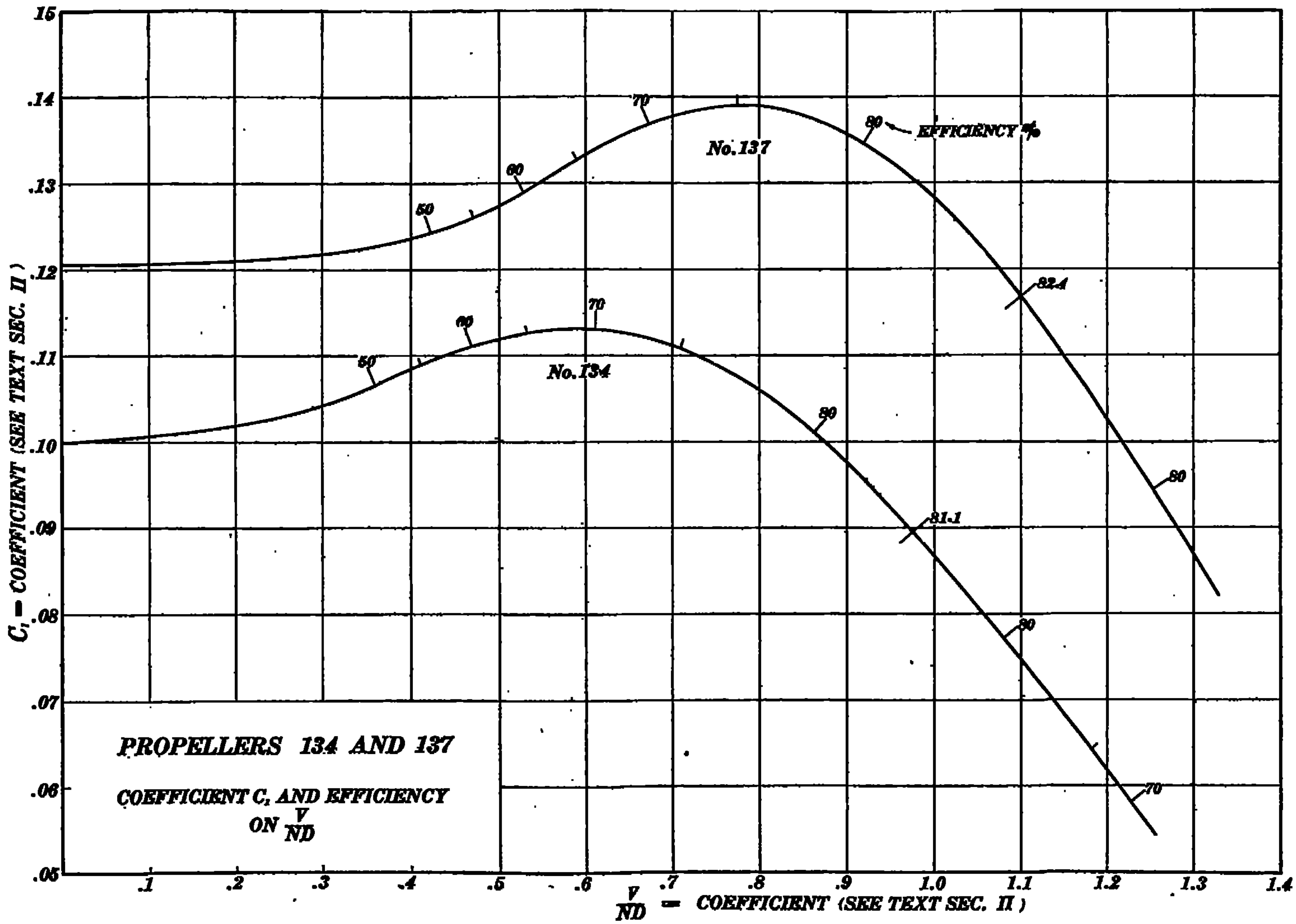

PROPELLERS 134 AND 137
COEFFICIENT $C_1$ AND EFFICIENCY ON $\frac{V}{ND}$
$C_1$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)
No. 137
No. 134
EFFICIENCY %
82.4
81.1
.15
.14
.13
.12
.11
.10
.09
.08
.07
.06
.05
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4

FIG. 51.

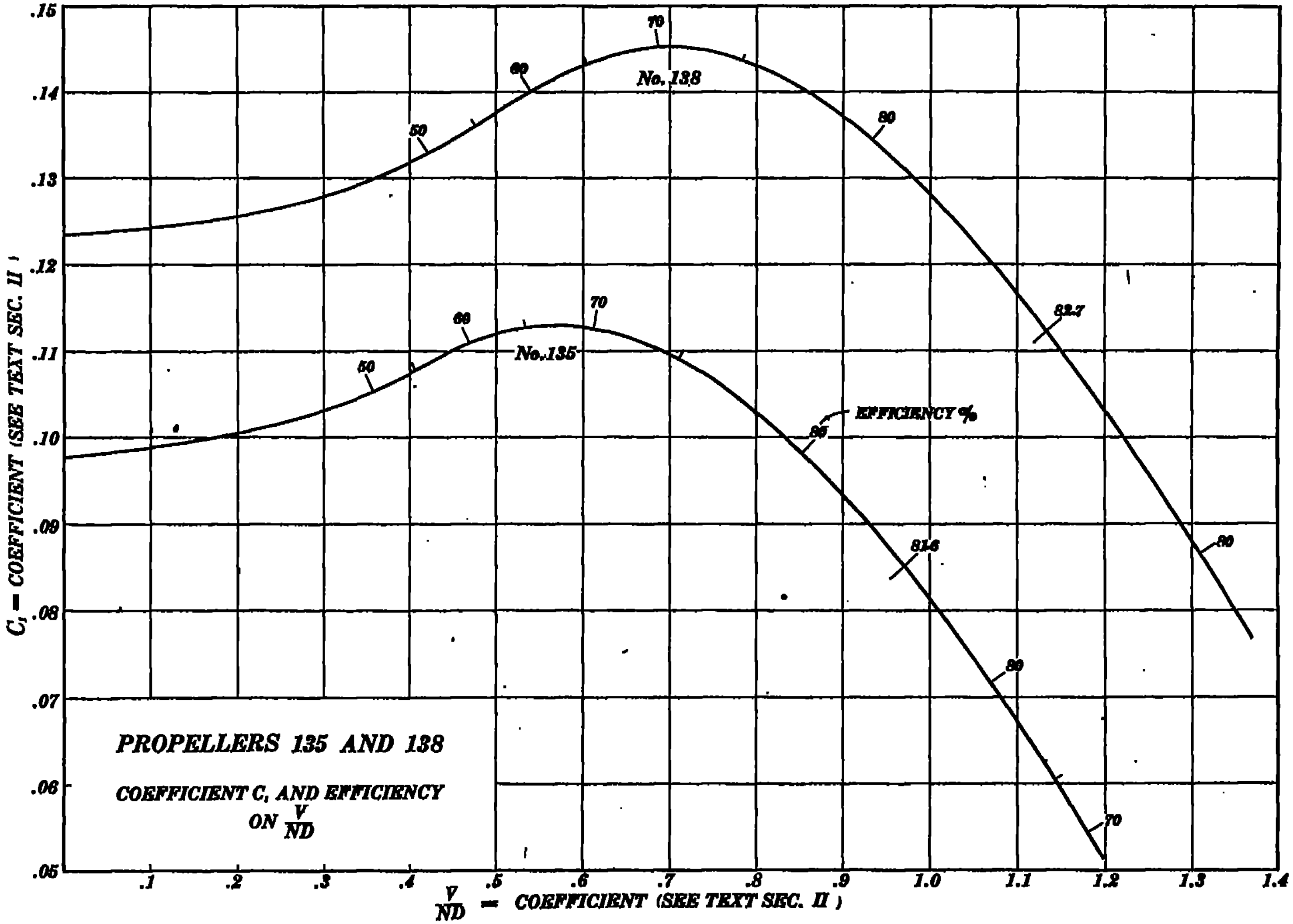
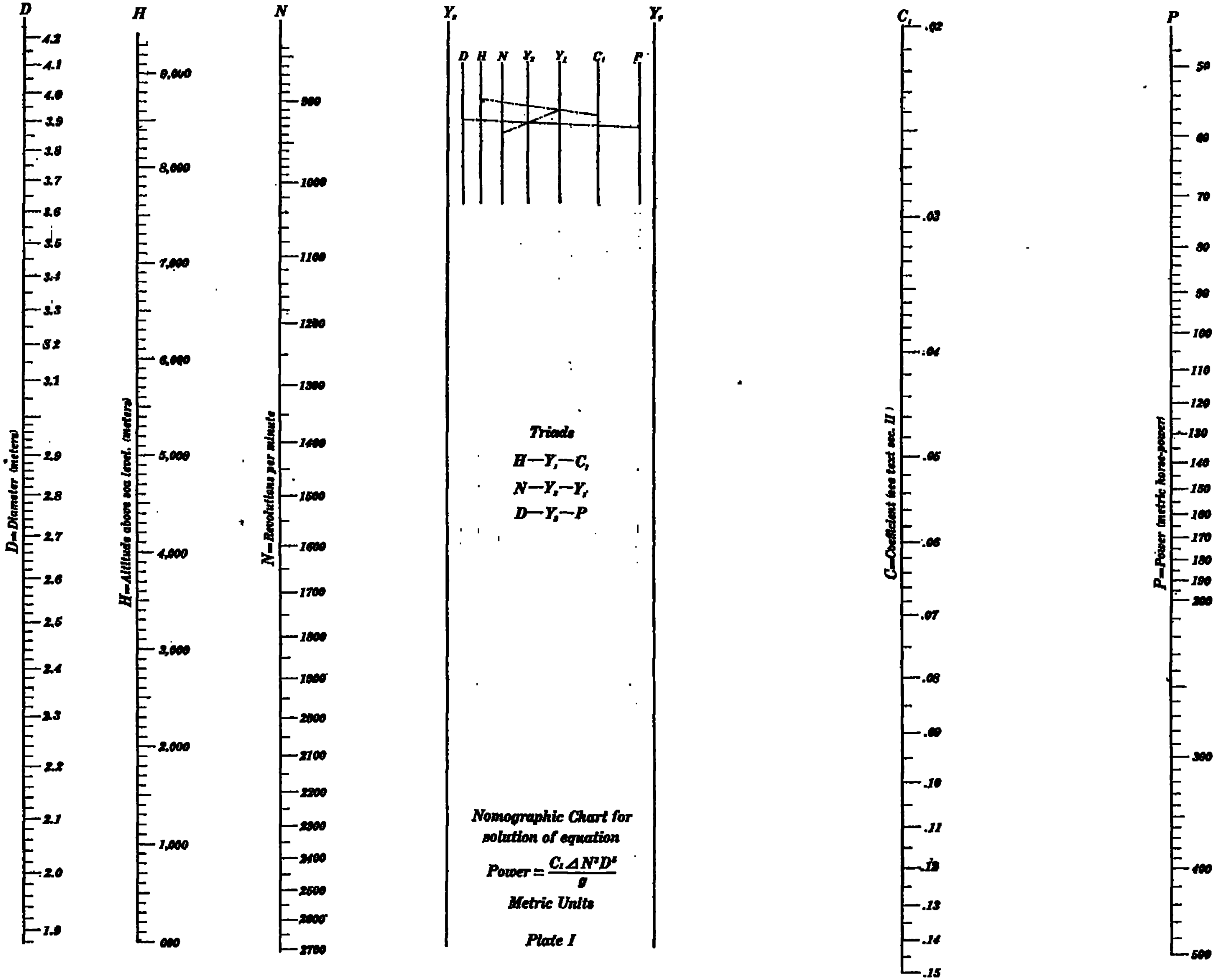

PROPELLERS 135 AND 138
COEFFICIENT $C_1$ AND EFFICIENCY ON $\frac{V}{ND}$
$C_1$ = COEFFICIENT (SEE TEXT SEC. II)
$\frac{V}{ND}$ = COEFFICIENT (SEE TEXT SEC. II)
No. 138
No. 135
EFFICIENCY %
.15
.14
.13
.12
.11
.10
.09
.08
.07
.06
.05
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.3
1.4
50
60
70
80
82.7
80
50
60
70
80
81.6
80
70

FIG. 53.

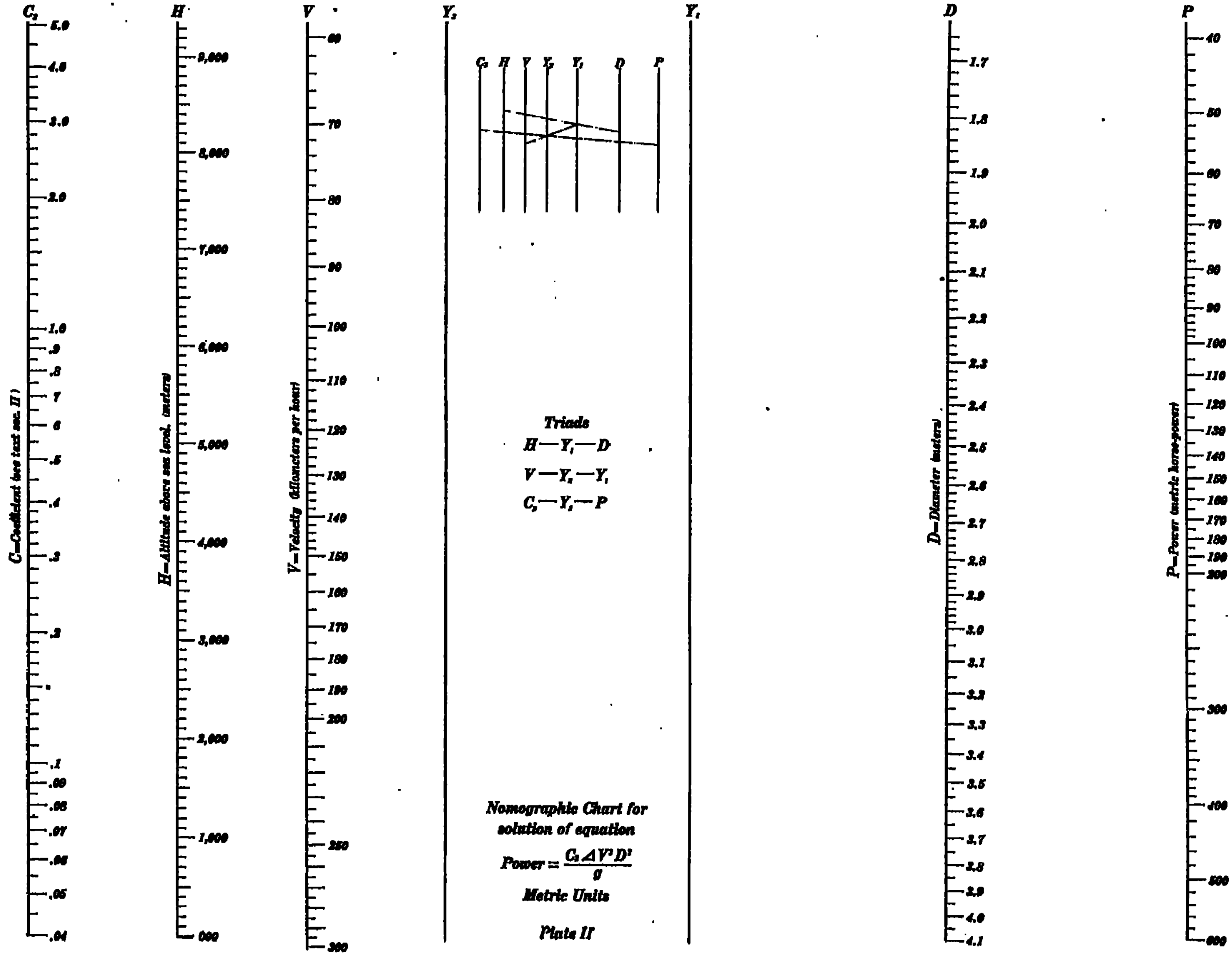



Nomographic Chart for solution of equation

$$\text{Power} = \frac{C_1 \Delta N^3 D^5}{g}$$

Metric Units

Plate I

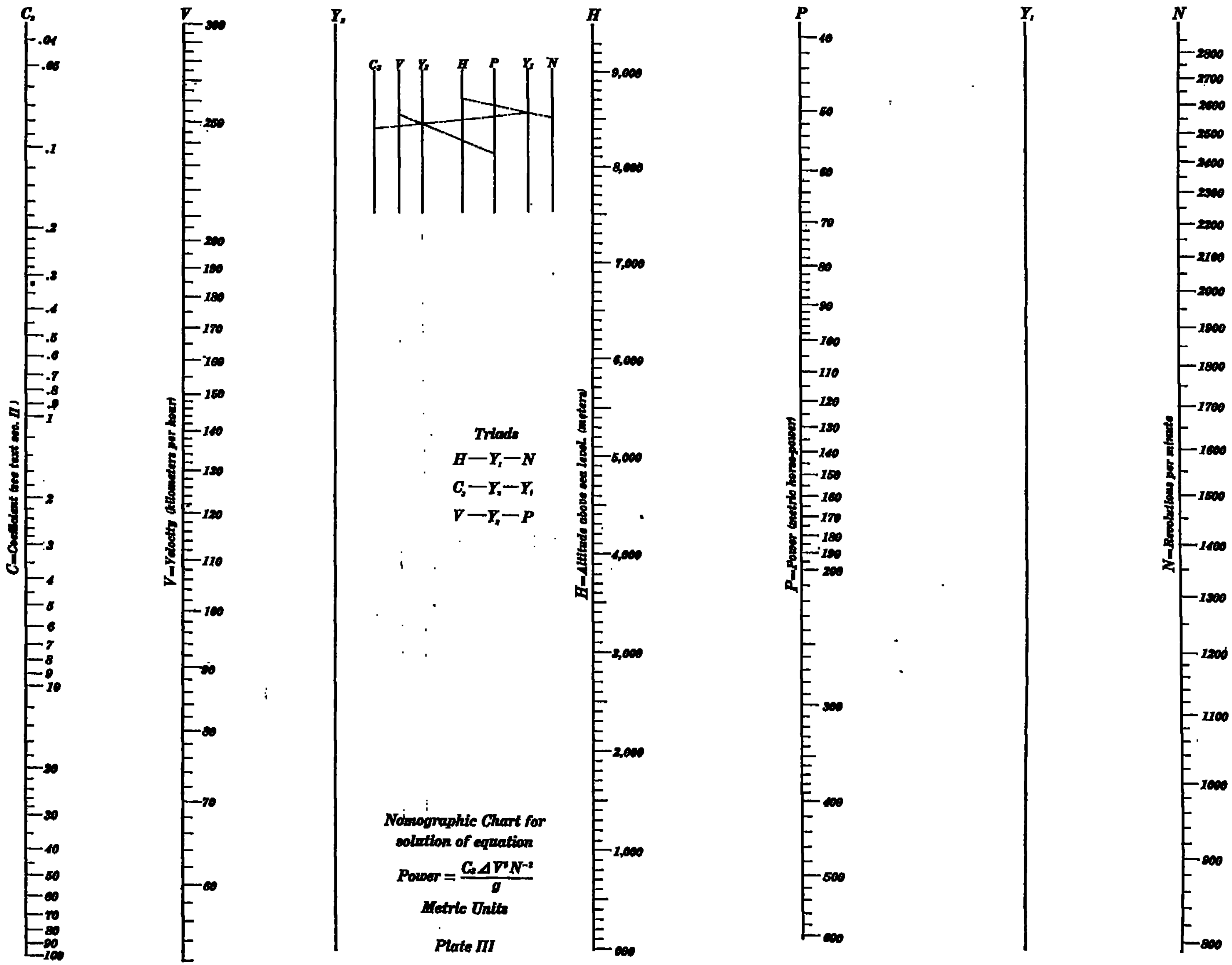



*Nomographic Chart for solution of equation*

$$Power = \frac{C_2 \Delta V^3 D^2}{g}$$

*Metric Units*

*Plate II*

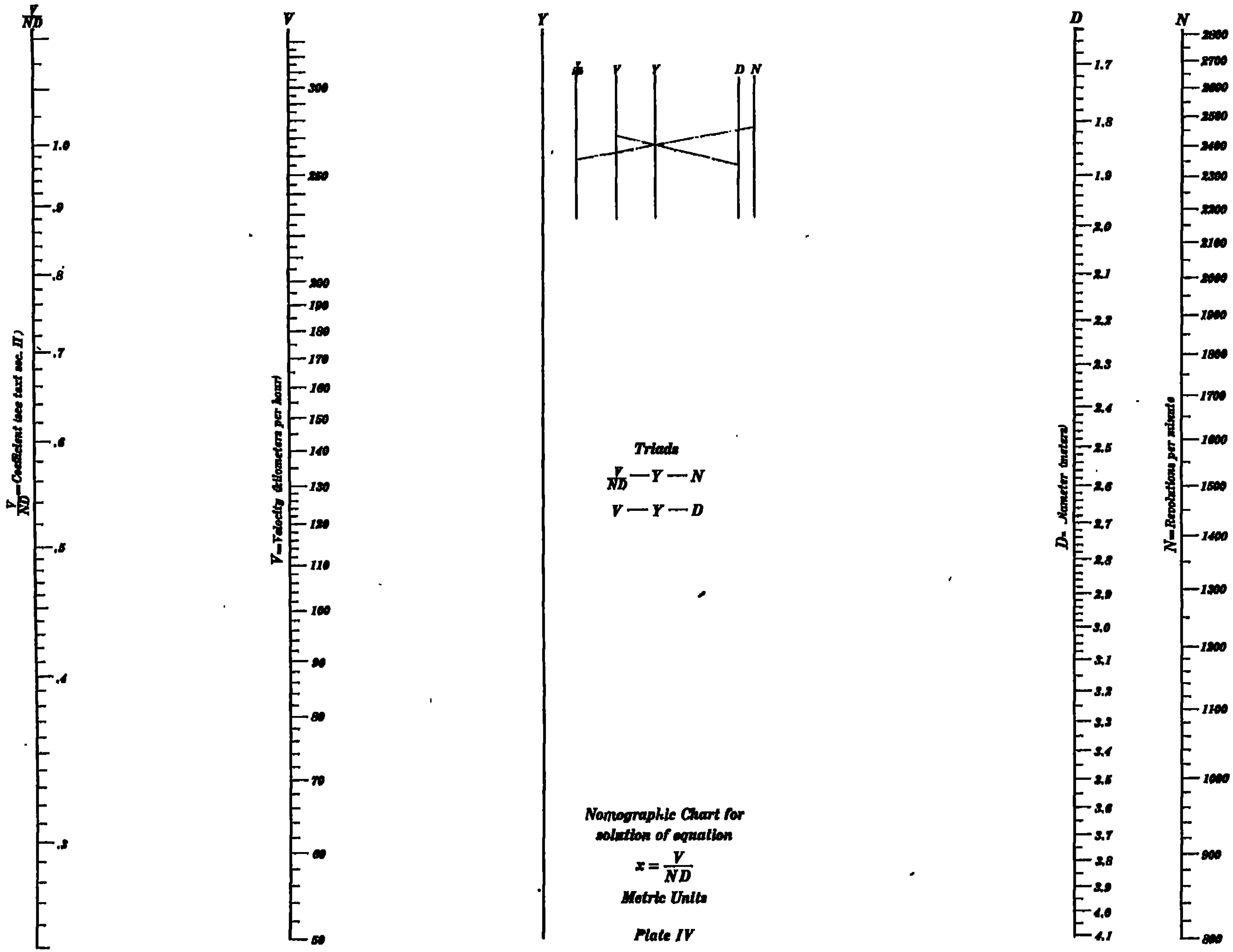



*Nomographic Chart for solution of equation*

$$\text{Power} = \frac{C_2 \Delta V^3 N^{-1}}{g}$$

*Metric Units*

*Plate III*

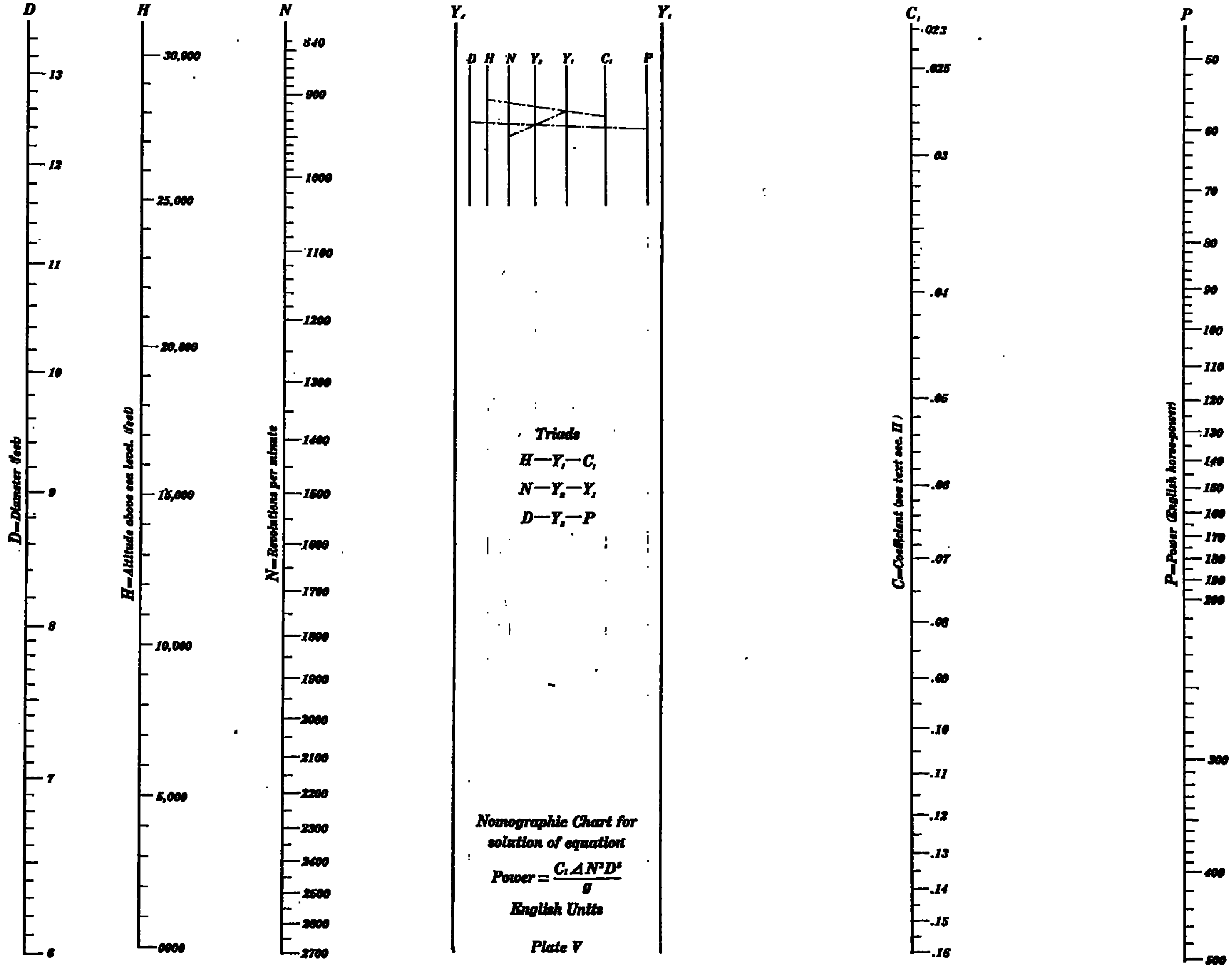



Nomographic Chart for solution of equation

$$x = \frac{V}{ND}$$

Metric Units

Plate IV

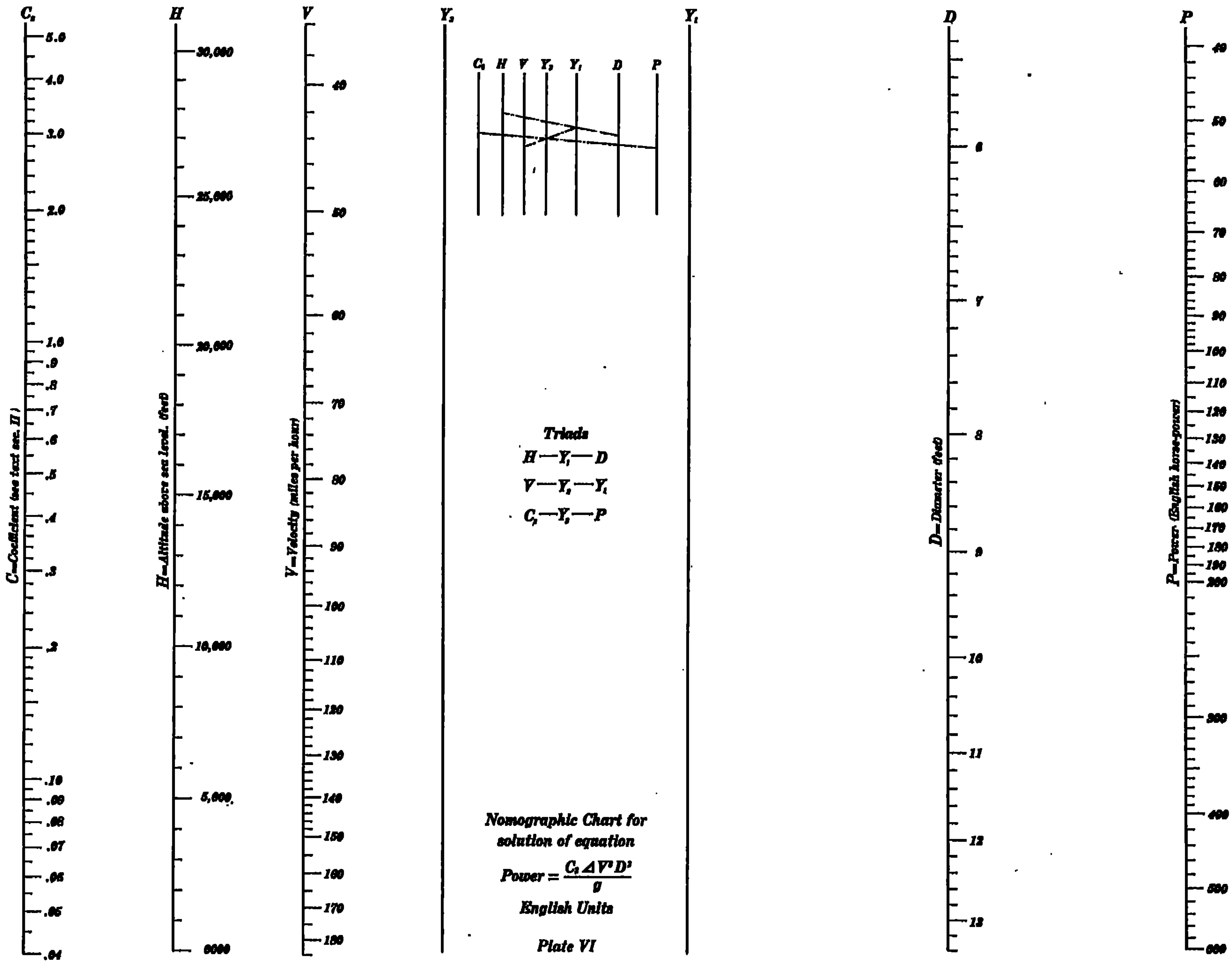


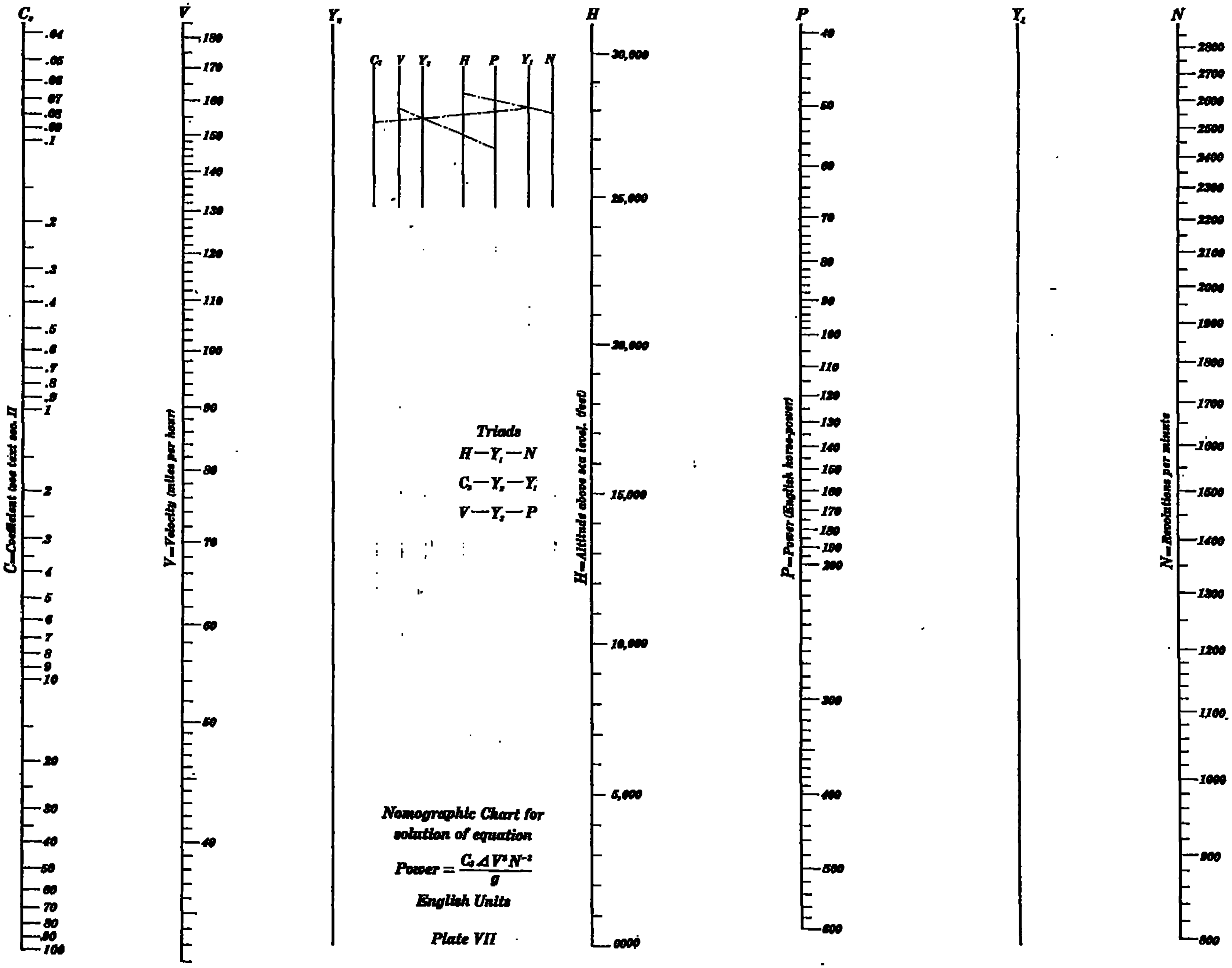

Nomographic Chart for solution of equation

$$Power = \frac{C_1 \Delta N^3 D^5}{g}$$

English Units

Plate V


C₂ H V Y₂ Y₁ D P
C—Coefficient (see text sec. II)
H—Altitude above sea level. (feet)
V—Velocity (miles per hour)
D—Diameter (feet)
P—Power (English horse-power)
Triads
H—Y₁—D
V—Y₂—Y₁
C₂—Y₂—P
Nomographic Chart for solution of equation
$Power = \frac{C_2 \Delta V^3 D^5}{g}$
English Units
Plate VI

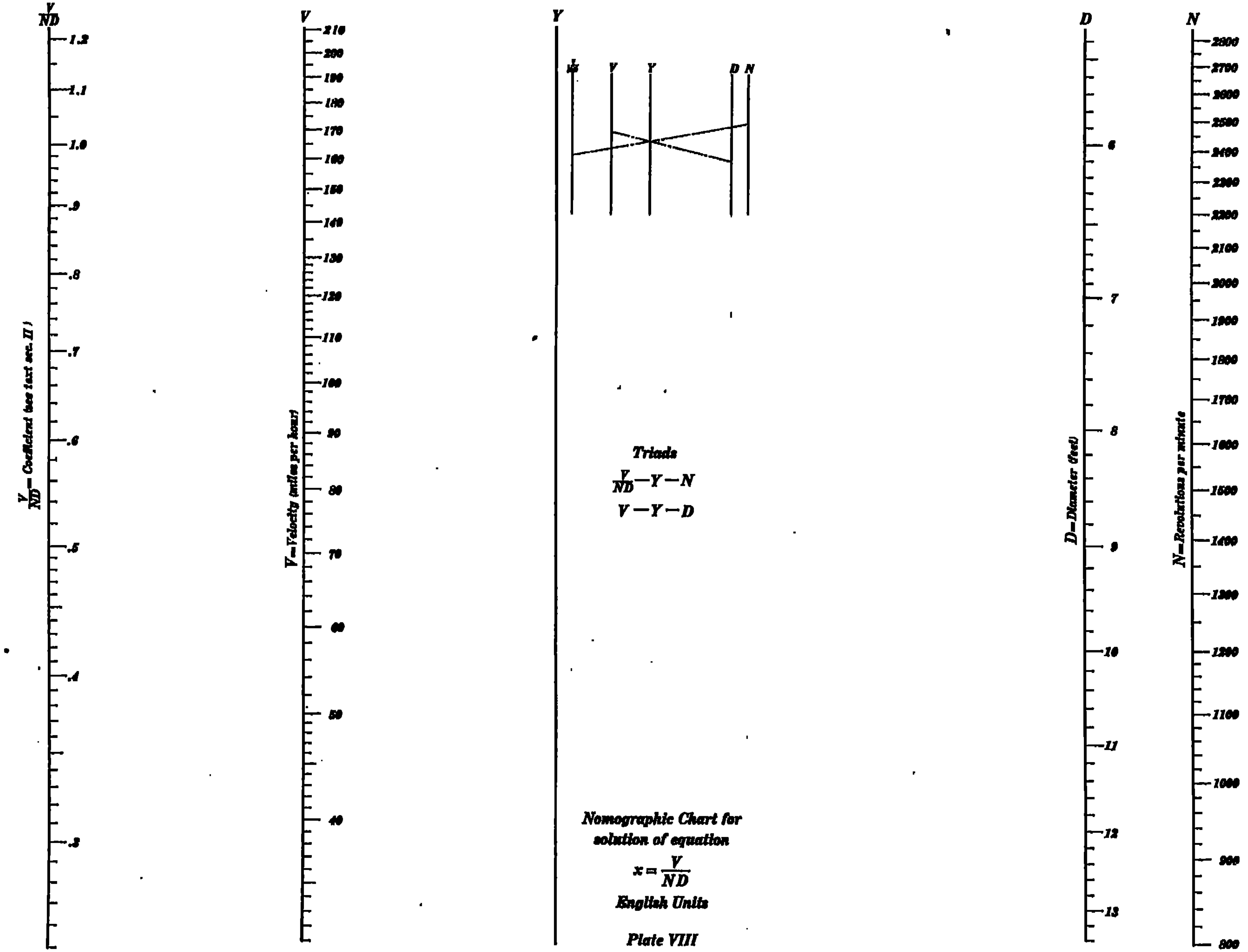



Nomographic Chart for solution of equation

$$Power = \frac{C_2 \Delta V^3 N^{-2}}{g}$$

English Units

Plate VII




Nomographic Chart for solution of equation

$$x = \frac{V}{ND}$$

English Units

Plate VIII